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THE Popular Science Review.

A QUARTERLY MISCELLANY OF ENTERTAINING & INSTRUCTIVE ARTICLES ON SCIENTIFIC SUBJECTS.

EDITED BY JAMES SAMUELSON.

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THE

POPULAR SCIENCE REVIEW.

THE BRITISH OAK.

BY PROFESSOR JAMES BUCKMAN, F.L.S. F.G.S. F.S.A. ETC.

WHILST the discussion is still pending, of iron against wooden bulwarks, if only for the love we feel towards the "brave old oak," a few notes upon the forms of this truly national tree can hardly fail to be acceptable. At starting, however, we must bear in mind, that though we have ever looked upon the oak as so thoroughly British that we had almost been brought to think that it was made for the sole glory of our land, yet there are those who would wish to cast a doubt upon its true aboriginal nature, and who, according to their custom, represent everything great as borrowed from the Continent. What says, however, that pleasant discourser on forest trees, Jacob George Strutt, of imperishable sylvan fame: —"In proportion as the oak is valued above all other trees, so is the English oak esteemed above that of any other country, for its particular characteristics of hardness and toughness; qualities which so peculiarly fit it to be the 'father of ships,' and which are so admirably expressed in two epithets by that great poet, to whom the book of nature, and of the human heart, seemed alike laid open:—

> Thou rather with thy sharp and sulph'rous bolt,
> Splitt'st the *unwedgeable* and *gnarled* oak,
> Than the soft myrtle."—SHAKESPEARE.

Selby again, in his "History of Forest Trees," a work which should be in the hands of all lovers of the beautiful natural objects of which it treats, describes the finding of some bog oaks, which would almost connect the present race with a fossilized past:—

> At the Linden, the seat of C. W. Bigge, Esq., the trunk of a magnificent oak was extracted from a peat moss that fills a small basin or hollow,

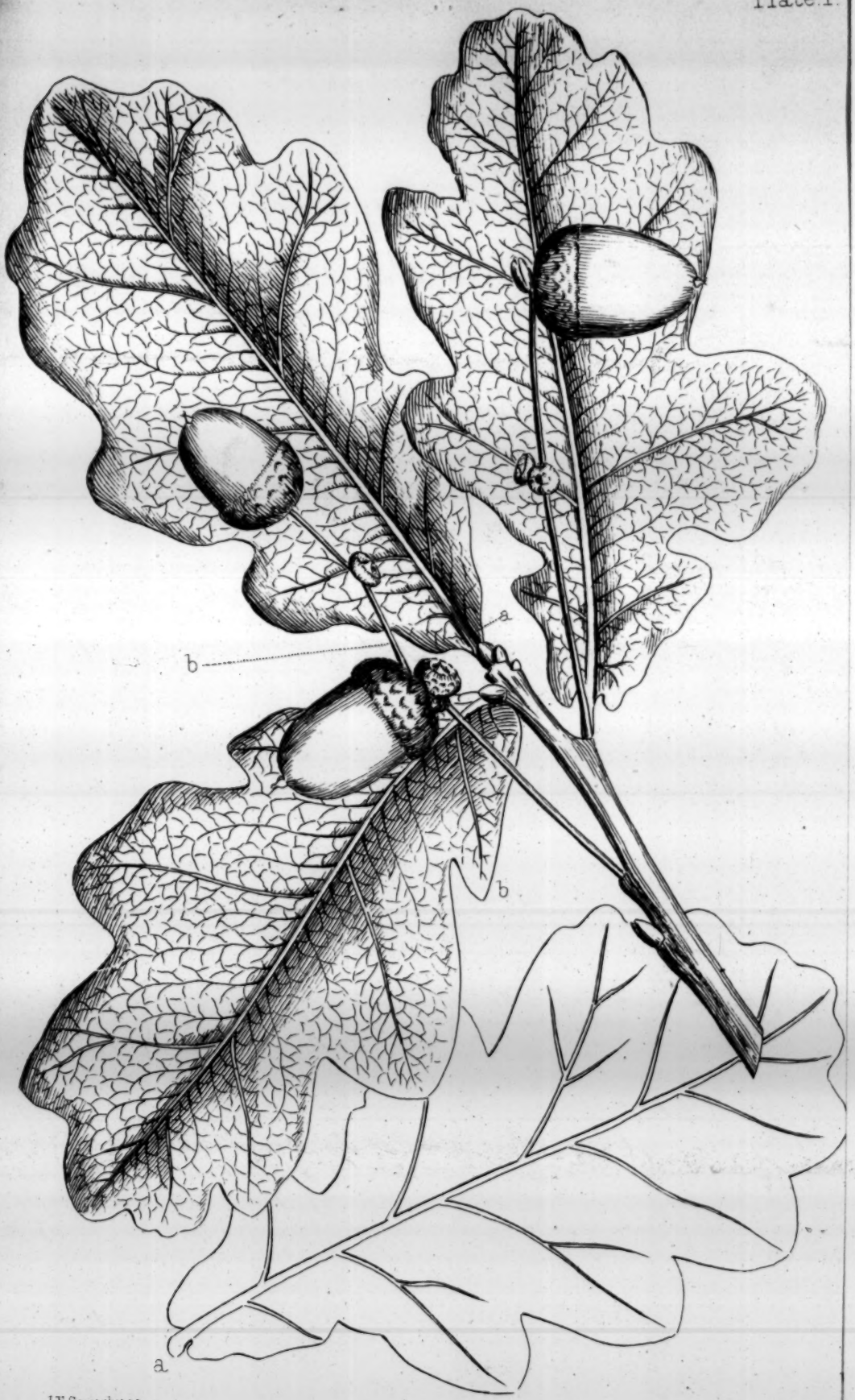
evidently produced by the stagnation of a stream, which now passes through it, and which, at some distant period, had been dammed back by the fall of the trees upon its margins. This oak was covered by a layer of the peat to the depth of about three feet, and was discovered by probing the moss. The trunk, with a small portion of one of the larger limbs, was with great labour and difficulty dragged from its miry bed. The contents of the portion recovered contained 545 cubic feet, although the whole of the sap-wood had perished. The timber was perfectly sound, and the tree, by whatever accident it had been overthrown, had fallen in the vigour of its growth. When sawn up, the interior planks were found of a deep rich brown colour; those nearer the exterior darker, or approaching to black. A variety of elegant furniture has been made from the wood, but it has been found necessary, for fine cabinet-work, to have it cut into veneers, for, when worked in bulk, it is apt to crack and become warped. Remains of other huge oaks have also been met with on the banks of the Tyne, the Alne, and other rivers, as well as in various bogs and morasses; and we mention these instances to show that in a district where, at the present day, nothing but recently-planted oak or dwarfish timber from stock-shoots exists, in former times the monarch of the forest grew luxuriantly, and attained a splendid development; and also as an inducement to the planter not to neglect the liberal insertion of this national tree wherever soil and situation are found congenial to its growth. In other parts of England, the oak still grows in all its native magnificence of form and dimensions, and the remains of those ancient forests, which are chronicled by our earliest writers, and which, in the time of our Saxon ancestors, spread over the greater portion of the country, are still to be traced in the venerable but living relics of enormous oaks, many of which are supposed to number more than a thousand years.

Not to neglect to plant the national tree! We hope indeed that there is no possessor of broad acres who does not esteem it a duty, regardless of profit, to provide for a succession of forest kings, if only to beautify the face of the country, and to leave the people of the present some grand living object to connect them with the history of the past. In fact, planting of the "British oak" has not only been considered a duty, but followed out with the keenest pleasure by the country gentleman. In so doing, the question has scarcely until lately occurred, is the British oak always the same? or, are there not different species, or at least varieties of the genus *Quercus*, which have been confounded by the planter? To this question we now propose to address our inquiries.

On referring to different authors, we shall find mention of the following names as applied to the British oak:—

1. Quercus Robur, *Linn.*
2. „ sessiliflora, *Salisbury.*
3. „ intermedia, *Don.*

This method of nomenclature would however be only tenable on the supposition that we considered the trees so named



J.E.Sowerby sc.

Quercus Robur Pedunculata.

specifically distinct; but as we incline to believe them to be only varieties—though highly important as such—we intend to treat of them as follows:—

1st. QUERCUS ROBUR PEDUNCULATA.
2nd. „ „ SESSILIFLORA.
3rd. „ „ INTERMEDIA.

1st. *Quercus Robur pedunculata* is readily distinguished in trees separate from others by its robust habits, thick, gnarled, twisted, and more or less horizontally inclined branches. The leaves have comparatively few broad wavy indentations, and are set on a short leaf-stalk (petiole) (Plate I. fig. *a*), the fruit being situate on long footstalks (peduncles), varying from two to upwards of four inches (fig. *b*).

This is the typical British oak, the pride of our sailors, when men fought bravely, and did not care to vie with each other as to who should make the most secure skulking-places. The tree,—

Whose roots descend
As low towards Pluto's realms, as high in air
Its massive branches rise. The utmost rage
Of wintry storms howls o'er its strength in vain.
Successive generations of mankind,
Revolving ages flourish and decay,
Yet still immovable it stands, and throws
Its vigorous limbs around, and proudly bears
With firm and solid trunk its stately form,
A mighty canopy of thickest shade.—VIRGIL, *Georg.* ii. 291.

This is the tree that seems to be longer lived than any other in Britain, and though it would appear to be the prey of nearly, if not quite, two hundred species of insects, it has still had vigour of constitution to survive them all, and, in many instances, we might point to brave old trees which must have been veterans at the time of the Norman Conquest. Now, however, they are old and staggy, with hollow trunks truly—but what trunks!—from forty to fifty feet in circumference, presenting the following picture to us as it did to Spenser:—

There grew an aged tree on the green,
A goodly oak some time had it been,
With arms full long, and largely displayed,
But of their leaves they were disarrayed;
The body big, and mightily pight,
Thoroughly rooted, and of wond'rous height:
Whilom had been the king of the field,
And mockel mast to the husband did yield;
And with his nuts larded many a swine,

But now the grey moss marred his rine;
His bared boughs were beaten with storms,
His top was bald and wasted with worms,
His honour decay'd, his branches sere.—*Shepherd's Calendar.*

This indeed is a melancholy sight, like the Stag's Horn Oak by the roadside between Farnham and Woolmer, in the ancient boundary of Alice Holt Forest; yet this has a young tree growing by its side, perhaps one of his own children, which gracefully conceals much of his gaunt nakedness. In the same forest are many old staggy trees, their contorted horn-like branches sticking out in a most picturesque manner from the top and sides of a still leafy head. In these the white owls may still be seen peering out of dark cavernous hollows as they did in Gilbert White's day; and during the summer of 1861 we with pleasure watched their motions, which so minutely agreed with those described by the father of observing naturalists, that we cannot forbear quoting his remarks thereon in his "Natural History of Selborne," a not very distant parish from the Holt, and to which he indeed often refers.

As I have paid particular attention to the manner of life of these birds (the White Owl), during their season of breeding, which lasts the summer through, the following remarks may not be unacceptable. About an hour before sunset (for then the mice begin to run), they sally forth in quest of prey, and hunt all round the hedges of meadows and small enclosures for them, which seem to be their only food. In this irregular country we can stand on an eminence and see them beat the fields over like a setting-dog, and often drop down in the grass or corn. I have minuted these birds with my watch for an hour together, and have found that they return to their nest, the one or the other of them, about once in five minutes; reflecting at the same time on the adroitness that every animal is possessed of as far as regards the well-being of itself and offspring.

Notwithstanding the good done by these birds in keeping under mice, all our eloquence could scarcely preserve them from the onslaught of the keeper; they were, however, protected during our pleasant sojourn at the Holt, but we much fear only, after all, to gratify the taste for stuffed birds, a *love* which is equally fatal to the feathered race (and especially the finest examples thereof), as the *hate* of the keeper.

But we are digressing sadly, and must return to *Quercus Robur pedunculata*, and complete our observations thereon with the statement that most, if not all, the nobler examples of oaks in England belong to this form. Selby directs attention to the "Flitton Oak, in Devonshire, of the *Sessiliflora* variety, supposed to be one thousand years old, and which is thirty-three feet in circumference at one foot from the ground." However, nearly every historical oak is of the pedunculate variety. In the Holt forest are still left some huge examples; the same

JE Sowerby sc

W West imp

Quercus Robur Sessiliflora.

in the Dean forest; and Ringdon, in Swindon, Wilts, though disafforested, can yet show noble trees of this form. Indeed throughout England it is difficult to meet with many examples of any other form, except in Wyre forest, Worcestershire, where the tree next to be described is perhaps the more general, and it would also appear that in the New Forest the *Q. sessiliflora* is also frequently met with.

Quercus Robur sessiliflora may be generally described as of a more upright and formal habit. Limbs straighter and less gnarled. Bark usually smoother than the former. The leaf has many sinuosities, and is set on a comparatively long leaf-stalk (petiole)—(Plate II. fig. *a*).

The fruit on the contrary is so nearly sessile that it may be said to have little more than the indication of a peduncle (fig. *b*).

We have already stated our opinion that the sessile-fruited oak does not usually attain the huge dimensions of the pedunculate form; but on the other hand we incline to the belief that it grows more rapidly, and is best adapted for a lighter soil than the latter. There are conditions which might to a greater or less extent affect the quality of its timber, but we do not think that there is much difference in this respect. We believe that their wood has been used indifferently, and the quality is influenced by surrounding circumstances. Selby, in his "History of Forest Trees," states on this head, "The result, perhaps, of some original constitutional defect, or arising from the nature of the soil, situation, or other local peculiarities of the ground upon which the timber has been raised, such at least is the result of our own experience, as we have met with oak of the *peduncled* kind, its timber possessing all the inferior qualities attributed to, and supposed to be possessed exclusively by *Q. sessiliflora*." The longer, straighter spars of the Sessiliflora, in days when oak was so uniformly used for roofs, seem to have pointed out this variety for roof-timbering, and hence some of the finest ancient timbered roofs of this country have been ascertained to have been formed from its wood. With respect to these the opinion long prevailed that they were formed of the wood of the Spanish chestnut. This, however, is but a poor timber tree, as long before it could afford so large a scantling as would be required by the roof of the Parliament House at Edinburgh or of Westminster Abbey (both of which were supposed to be of chestnut), the chestnut would begin to decay at the heart; in fact just at the period when the heart-wood of oak begins to harden, that of the chestnut would appear to deteriorate.

Quercus Robur intermedia, having a petiole intermediate in length between the other two varieties described, and a peduncle

varying from a quarter to one inch in length, may with propriety be deemed a variety intermediate between "Sessiliflora" and "Pedunculata," and a comparison of the three will substantiate its claim to this title.

As a tree it is impossible to make out any specific character from its mode of growth, and, indeed, without the fruit, it is extremely difficult even to distinguish it as a variety.

It occurs—only occasionally—in the Cotteswold district, and we suppose the same elsewhere. One meets with it here and there in the hedgerows, and in Oakley Park, the seat of Earl Bathurst, we can point out a few specimens.

Passing from the subject of the varieties of our British oak, it now remains to mention a most formidable enemy by which it has of late years been attacked, and so exclusively, that in plantations where may be found the American oaks, the Ilex oak, and Turkey oak trees, it has been the only one subjected to the operations of the new gall pest. It has long been known that our native oaks were subject to excrescences of different forms and sizes, such, for example, as oak apples, oakleaf galls, oak spangles, &c., all of which were ascertained to be caused by several species of *cynips;* but lately, we have to lament the introduction of a new species of the same insect, forming a new kind of gall, which, instead of attacking the backs of the leaves, as does the oakleaf gall, occupies the stem that belongs to the leaf; in fact, the attacked leaves seem to be converted into bunches of galls, as represented in the adjoining figure, which presents an illustration of the new pest. They are hard galls, more or less like the "nut-gall" from Aleppo, of which ink is made, and it will be seen that the little twig supports no less than five galls, in the interior of each of which may be found the maggot or *larva* of an insect; and, as this is effected at the expense of the buds and leaves, the mode of injury must be obvious, as the new twigs which would have been formed, had there been no galls, would

Galls of the *Cynips Quercus-petiolata.* (Natural size).

in their turn have produced branches and leaves. Trees thus infested are crippled as though they had been subjected to constant pruning.

As much of the natural history of the *cynips*, by which these gall-nuts are formed, as is necessary for our purpose, may be gathered from a paper by Mr. Parfitt, who seems to have well studied the gall insect in Devon, its head quarters. We quote it from the Journal of the Bath and West of England Agricultural Society for 1861 :—

The eggs deposited by the females in the oak buds in September remain there in a state of apparent quiescence till the following spring; then as soon as the sap begins to flow, the irritant injected into the wound at the same time the egg was deposited, or possibly the combined action of the egg and irritant, causes the sap to diverge; that portion of the bud which should have formed a young shoot, is converted into a spherical ball; the outer scales of the bud fall away, and it is the woody secretion which entirely forms the gall. The cells in the gall are not elongated and regular, as in the young shoot, but confused and irregular; and in the centre of each gall lies a young grub of the *cynips*, forming a living nucleus, around which is deposited a thin hard woody envelope, much more compact in substance than the sponge-like tissue which fills up the interstice between it and the shining outer coat of the gall. This compactness of structure is a necessary and all-wise provision of nature for protecting the delicate insect which lies within from destruction; for if the gall were composed entirely of large spongy cells, the rapid flow of sap in the early spring would be more than the creature could consume, and it would consequently be drowned. I am aware that some naturalists incline to the opinion that the *larvæ* of the *cynips* feed on the gall. From this view, however, I venture to dissent; for not only is it inconsistent with the structure of the creature's mouth, and the position in which the young *larvæ* are invariably found, with the head tucked under the apex of the abdomen, but if they fed on the substance or crude material of the gall, the undigested parts would certainly be found in the interior of its cell: in other words, the excrement would be there, for there is no outlet, and the lacteals or absorbent vessels of the gall could not take it up. I therefore think that the creature feeds entirely on the sap of the tree—an elaborate food fit for it without the need of mastication. This explains how it happens that the galls of commerce, with the insects in them, are so much better and dearer than those from which the *cynips* has escaped; in a word, the tannic acid is more abundant.

It has been before observed, that there are two broods of the insect in a season; thus, those which do not emerge from the gall in September, remain on till the following April or May. This is a wise provision of nature for continuing the species, should anything befall the autumn brood; and it is the more deserving of notice, because the gall-producing *cynips* has a deadly enemy which accompanies or follows it in its flight from bud to bud, and deposits an egg wherever it finds the egg of the *cynips*. Here, as soon as the *cynips* larva is hatched, the larva of the parasite is hatched also; forthwith the latter proceeds to eat a hole in the skin of the rightful occupant of the nidus, and the

two larvæ go on growing together till the *cynips* is ready to assume the pupa state; then the parasite cuts the vital thread of the *cynips* and uses its skin for a pupal envelope for itself, and thus, instead of the gall-fly emerging into day, a beautiful green insect makes its appearance on the stage of life. I had the pleasure of first discovering this parasite while engaged in studying the *cynips*; it belongs to the genus *Callimome*, and from the fact of having discovered it in Devonshire, I gave it the name of *Callimome Devoniensis*. It is one of the handsomest of our British insects; its costume a brilliant green, shot with gold; the abdominal segments green, gold, and purple; legs yellow; tarsi reddish; and it has four beautiful transparent and irridescent wings.

It has been stated that oak-galls are produced at the expense of acorns. From this view, my experience leads me to dissent. In exceptional instances, it may have been the case; but, as a rule, the *cynips* confines its attacks to young trees and young growths in hedges, within a range of ten or twelve feet from the ground, and the nearer the ground the more numerous the galls. Young trees which have not attained a greater height than that I have indicated, suffer so much, that many of them can scarcely make headway against their foe; and in several nurseries I have visited, where it might be expected that greater care would be paid than in the case of ordinary plantations, the young stock of oaks has been rendered quite unsaleable by the pest. This year I have noticed the progress of the insect on two groups of young English and Turkey oaks growing side by side; and although there are hundreds of galls on the English oaks, there are none on the Turkey oaks. From this I am led to infer that the species of *cynips* now under notice is confined in its depredations to the English oak; and as it invariably selects trees of younger or restricted growth—probably because the temperature at a higher elevation than ten or twelve feet from the earth is unfavourable to it—it would seem that children might be advantageously employed in young plantations in collecting the galls by means of cutting hooks, such as are used for thistles. The galls, when once collected, might either be crushed for tanning purposes, or consumed by fire, and if the process were repeated for two or three seasons, it is more than probable that the plantation would be altogether freed from the pest.

These able remarks not only well describe the nature of the attack, but also point to a cure, a matter to which we would direct the most serious attention of the planter; for we may state that, in 1853, we saw some very small oak trees, in the neighbourhood of Dawlish, Devon, from which some hundreds of these galls might have been gathered. This was the first time we had noticed this pest, though it appears that it had been under Mr. Parfitt's notice as long as a dozen years. Since then (1853) we have traced it in its progress as follows:—

Having observed the galls in Devon in 1853, we were yearly on the look-out in the Midland and Eastern counties for its appearance, and the following dates will show that its spread, though gradual, was sufficiently rapid:—

The galls were gathered in Devon, in 1853
The same kind in Somerset, in 1854
In Gloucester, on the west side of the river Severn, Forest of Dean, in 1855
In Gloucester, east side of the Severn, and as far as Oakley Park, Cirencester, in 1856
In Worcestershire, in 1857
In North Wales, Beddgelert (pointed out to us by John Savory, Esq.), in 1859
In Sussex, very sparingly, in 1860
In Alice Holt Forest, and far from abundant, in 1861
About Hastings, very plentifully, in 1862

We have this season observed a lot of the young galls, but last year, for the first time, we discovered that, in many cases, the maggot had been extracted by some small bird, probably one of the titmice, and, if so, wherever young oaks may be growing, it should afford an additional reason for the protection of these useful birds. The magnitude of the evil, unless checked by some means, may be estimated from the fact that, in 1856, we could scarcely find half a dozen galls within a wide district, and now all around may be found trees, not more than ten feet high, upon which are no less than from one to five hundred distinct galls.

We conclude these remarks upon our native oaks with the fervent hope that in "Merrie England" it may ever be as described by dear old Chaucer:—

A pleasant grove
* * * * *
In which were okes grete, streight as a line,
Undir the which the grass so fresh of hew
Was newly sprong, and an eight fote, or nine,
Every tree well from his fellow grew,
With branches brode, laden with levis new,
That, sprongin out agen, the sonnè shene.
Some very rede; and some a glad light grene.—

The Floure and the Leafe.

DESCRIPTION OF THE PLATES.

Plate I. QUERCUS ROBUR PEDUNCULATA, nat. size, from Oakley Park, Cirencester.
Fig. *a.* *Petiole* or leaf-stalk.
b. *Peduncle* or fruit-stalk.

Plate II. QUERCUS ROBUR SESSILIFLORA, from Wyre Forest, near Kidderminster.
Fig. *a.* *Petiole.*
b. *Peduncle.*

THE COMMON RED WORM OF OUR RIVERS.

(TUBIFEX RIVULORUM).

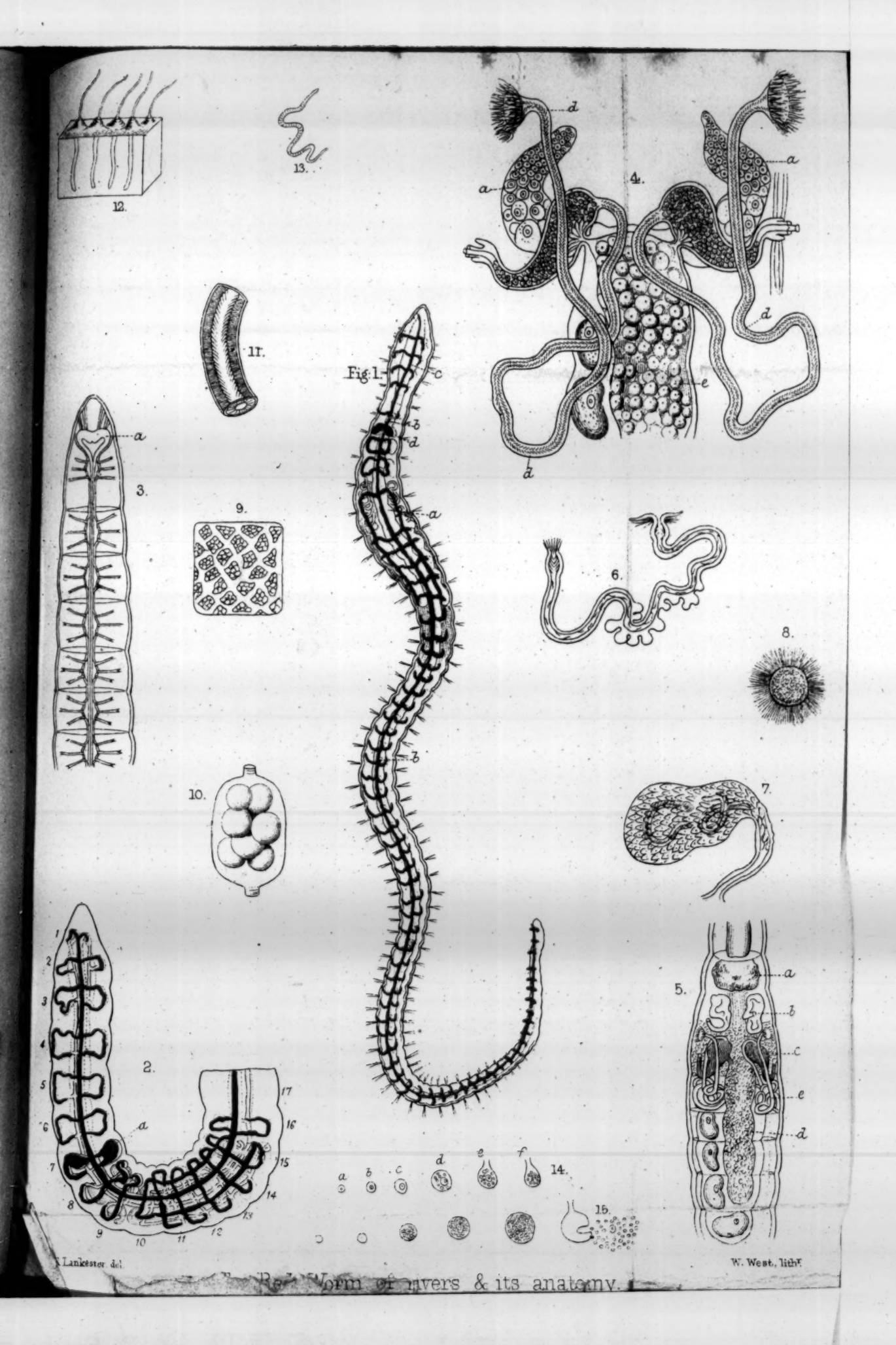
BY E. RAY LANKESTER.

NO river has enjoyed so large a share of odium as our old friend Father Thames. The medical world anathematizes its noxious exhalations; our witty contemporary "Punch" ever and anon cracks a joke at its expense; but like all old folks who have jogged along quietly for a series of years in the same smooth channel, our patriarch gives little heed to the insults that are heaped upon his grey head, or retaliates upon his assailants by giving them an additional dose of poison.

However we may agree with its accusers, from a sanatory point of view, we don't mean to fall out with the good old stream that has often-times served as our high road eastwards or westwards; we mean rather to court its favour and earn its good wishes, for we have found something in the midst of its filth, which will, we trust, redeem it from utter condemnation, and will serve to show that there are not only "books in running brooks," but that even muddy rivers yield themes for study and investigation.

The living object which we are about to describe is found not alone in the river Thames, but also in many others. We have, however, obtained it from our own stream, near Waterloo Bridge, at low-tide, and it is then so plentiful as to tinge the mud, which serves as its habitat, with a dull-red colour. Doubtless our readers will be somewhat incredulous when we assert that repulsive as is the locality in which it occurs, nay, distasteful (to use a mild expression), as is the object itself, a worm, to the large majority of unscientific persons, this one is really beautiful as seen under the microscope.

It resembles a crystalline snake, both in appearance and movement, through whose hyaline skin all the internal organs of life are seen in active operation. Not only, therefore, is it interesting as a microscopical object, but its transparent envelope, which reveals its internal anatomy, and the great facility with which it may be obtained, point it out as an object of especial value to young students in the anatomy of the lower animals; and we trust that our short review of its various parts



Re... Worm of ...vers & its anatomy.

may be the means of inducing many such persons to examine and confirm our statements concerning its anatomy.

Tubifex rivulorum (the River Tubifex), for so it has been called by the eminent naturalist Lamarck, belongs to the family of Lumbricidæ, or Earthworms; and the sub-family Naiadidæ, or water-worms, according to some naturalists (for they burrow in the mud of rivers), whilst others rank it amongst the "Setigeræ," or bristled worms (in consequence of its being furnished with two lateral rows of bristles), but in the same group, Lumbricidæ or Lumbricini. However we need not discuss this question with our differing authorities; but may just observe that Tubifex is a genus of Annelides, allied to the Earthworm, having the rings indistinctly marked, and that it forms one of a group of fresh-water worms which burrow in the mud of rivers and ponds. It is from half an inch to an inch and a half long (Plate III. fig. 13), and is attenuated at each end.

Owing to its various modes of reproduction it increases very rapidly, and its numbers cause patches of red on the surface of the mud on which it burrows, for half the bodies of the worms are protruded (fig. 12), the other half remaining in the ground. When the worms are disturbed, they withdraw their bodies, and then "the red patches instantly disappear, from the retraction of the animals."*

With the aid of the lens, its "annulose," or ringed character, is revealed, but, as just stated, not so clearly as in the earthworm.

Our figure (1) represents a magnified view of the animal, and from this it will be seen how clearly the internal organs are visible. These we shall now proceed briefly to describe.

First we have along the whole length of the body the digestive canal (fig. 1, *a*), a dark tubiform organ, and attached to it (fig. 1, *b*), the dorsal blood-vessel of a deep red colour. Extending from the eighth to the sixteenth ring we find a white semi-opaque mass, comprising the organs of reproduction, which are of a very interesting nature, for we here find, as in many allied forms, both the male and female united in one individual.

In connection with the red dorsal vessel are two hearts, if we may so term them (fig. 1, *d*), which impel the blood through the numerous blood-vessels, of which the rhythmical dilatations and contractions are clearly distinguishable.

We have already remarked that the *external envelope* of *Tubifex* is transparent. Let us now add that it consists of two layers, namely, a very thin "epidermis" or outer integument, and an internal skin or "chorion," which is intimately connected with the muscular membrane lying underneath the skin. The

* Griffith & Henfrey's Microscopic Dictionary (Van Voorst), article "Tubifex." Here also will be found the Bibliography.

"muscular membrane" envelops the whole body, in common with the skin, and attached to it are transverse muscles which constitute the boundaries, as it were, of the rings of the body. These muscles, by their contraction, impart to the little Tubifex its undulating and longitudinal movements, and a probable modification of them is found in another set of muscles at the mouth of the animal, these latter being intended to regulate the movements of the pharynx (fig. 1 *c*).

The reader will no doubt be somewhat surprised to hear that so diminutive an organism should be furnished with a complicated nervous system, perfectly adapted to its general structure, and for the fulfilment of its wants.

A careful examination of the little annelide is necessary for the definition of the *nervous system*, which is found to resemble the other forms of this order. It consists of a long double cord of nervous fibre, which runs throughout the length of the worm, and gives off in each segment of the body three pairs of nerves, which direct the movements of the muscles belonging to that ring. The points in the nervous cord whence these nerves spring are slightly enlarged, and are called "ganglia" (fig. 3).

In the first ring of Tubifex we find a very large ganglion (fig. 3, *a*), the two nervous cords enlarging into a round mass composed of nervous matter; this represents the brain of higher animals, and from it spring two pairs of nerves, one of which is connected with an organ supposed to be the eye; but of this there is great doubt. We ourselves have tried several experiments to ascertain whether the Tubifex has been favoured with organs of sight or not, and have come to the conclusion that it is blind. The Creator has nowhere exercised his Almighty power uselessly, and eyes would certainly be of no use to our little annelide, as his food consists merely of the mud which he inhabits, from which all the nutritive matter is extracted in his intestinal canal.

Strange though it may seem, the Tubifex is provided with a *liver*, and a very large one too, and is therefore liable, in common with the human race, to bilious attacks. The intestine is covered throughout its length with a dark yellow membrane containing curious little granules (fig. 14), and capable of secreting and projecting a fluid into the intestine—this is the liver—and is no doubt most important in digesting such *bonnes-bouches* as Thames mud affords.

The animalcule is also provided with excretory organs answering to the *kidneys* in higher animals—there are two in each ring of the body—consisting of little tubes with an internal and external opening covered internally with minute vibratile hairs or "cilia," which are also continued around the expanded orifices, as seen in fig. 6. When the Tubifex is placed under the microscope, these "cilia" may be seen in rapid motion,

and present a most beautiful appearance. The same excretory tubes may be found in the common earthworm (*Lumbricus terrestris*), and are there visible to the naked eye. These cilia are found in other parts of the body—the interior of the intestine is lined with them, and they are easily seen at the extremities of the body, in continuous movement when the Tubifex is under the microscope.

We must now say a little more about the *blood-vessels* of our worm Besides the long vessel which runs along the intestine, called the dorsal vessel, we find another placed below the intestine, of rather smaller proportions, also running through the whole length of the body. These two blood-vessels are connected by smaller ones, as seen in figs. 1 and 2—a pair in each ring of the body; in the seventh ring of the body, counting downwards from the cephalic or head-segment, we find the two hearts, which are merely enlarged lateral vessels (fig. 2 *a* and fig. 1 *d*). It is a most beautiful sight to see these little hearts contracting and expanding while they send the blood through the various ramifications of the blood-vessels. In the region of the reproductive organs (from the eighth to the sixteenth ring of the body), there is an interesting modification of the lateral vessels. They are connected by two vessels which run parallel with the great dorsal and ventral arteries, the arrangement of which will be best seen from the plan of the circulation given in our drawing (fig. 2).

We must now say a word or two concerning the reproductive apparatus, which is very complicated, the male and female organs being, as we before said, united in the same individual. In the eighth ring of the body, underneath the intestine, there is a round semi-opaque mass (fig. 5 *a*); this is the male glandular organ, and at the proper season of the year it is full of the spermatic filaments, which are often found collected together in discs somewhat resembling the beautiful little Sun animalcule (fig. 8). At a certain period the case enclosing these "Spermatozoa" bursts, and they float into the cavity of the body; thence they pass into a pair of ciliated tubes which are found coiled up in the tenth ring of the body (fig. 4 *d* and fig. 5 *e*). These little tubes, like the excretory tubes, have large trumpet-shaped mouths, and are lined with minute cilia, the arrangement of which is seen in fig. 11. The arrangement of the other organs of reproduction will be best seen in figs. 4 and 5. The ovaries (fig. 4 *a*), contain eggs in all stages of development, which pass from them into a large cavity where they are probably fecundated, as we find the ciliary tubes likewise connected with this part of the body. At the time that the eggs are deposited they are enveloped in little gelatinous capsules, each containing two or three eggs (fig. 10). These little capsules

are formed by two glands found in the eighth ring of the body (figs. 7 and 5 *b*); they present a most beautiful structure, being composed apparently of polygonal cells: in their interior are found little vermiform bodies which assist in the secretion of the fluid that forms the egg-capsules. The eggs are probably deposited by a spontaneous dehiscence or rupture of the body, there being no natural outlet. Fig. 9 represents a (probably) secretory organ met with in the ninth ring of the body. Its function is not known.

Whilst speaking of the circulatory system we should have mentioned that the general cavity of the body is filled with a fluid which surrounds all the internal organs. It contains numerous small granules of various sizes, very similar in appearance to those found in the *quasi* liver enveloping the intestine (fig. 15). This liquid is probably merely pure water which brings the needful oxygen to the capillaries of the Tubifex, and answers the purposes of *respiration*. Such an arrangement is met with in many annelides, and is known as the chylaqueous system.

Our little Tubifex not only presents us with a wide field for study and amusement in the investigation of its anatomy, but it actually forms the habitat of at least two very interesting forms of animal life. One of these is met with in the interior, the other attached to the exterior of the body. The animalcule which resides in the interior of the Tubifex is a species of Opalina; it is very minute, and is covered by spiral rows of cilia, giving it, when in motion, an extremly beautiful appearance. It is one of the lowest forms of animal life belonging to Ehrenberg's class Infusoria. The other parasite which we have met with in studying the Tubifex is the beautiful Vorticella. We have examined but few specimens without finding a cluster of these exquisite living forms attached to the head or tail of the worm. The Vorticella, like the Opalina, is very low in the scale of creation, but it is of an entirely different form: supported by contractile stems there are numerous cup or bell-shaped bodies fringed round their margins with beautiful cilia.

Thus it will be seen that even in localities and substances which are repulsive to the ordinary mind, the inquiring student may find living forms of intricate structure performing complicated natural functions, and affording a habitat for still simpler but equally interesting forms of life. Even this imperfect and cursory review of the anatomy of the little Tubifex cannot fail to have afforded confirmation of the great truth, that all things are created in wisdom, and we may once more repeat that not only is it possible for the thoughtful man to read "sermons in stones," and find "books in running brooks," but that even the muddy bed of a broad river yields its volumes for the edification of the inquiring mind.

ANÆSTHETICS.

BY T. L. PHIPSON, M.B., PH.D., F.C.S.

BY anæsthetics are understood certain substances which have the property of inducing a peculiar state of the nervous system called anæsthesia, and thereby rendering us insensible to pain. They rank among the most powerful, and, at the same time, most useful agents that man has hitherto obtained from the hidden treasures of nature. From the moment of his birth (and perhaps even some time before birth), man is liable to experience what is called pain. The human body is so organized that, in a state of perfect health, we feel nothing; and there are some persons, though few indeed, who pass through life almost without knowing what pain is, whilst others again are almost constantly in a state of suffering. When pain is felt in any part of the body, that part is not in its normal condition, it is no longer in the state of insensibility which characterizes perfect health.

But pain is not without its uses: it warns us from danger, and without its existence our own existence would infallibly cease. For instance, if no pain were felt when the hand or foot is placed in the fire, we should not be tempted to withdraw it unless we happened to see it consuming. Some time ago a labourer lost his leg by sleeping too near a lime-kiln; he *felt* nothing till he awoke, when it was too late. Likewise, if no pain were felt when boiling water, or some powerfully acrid substance, is poured down the throat, we should not be tempted to desist from introducing it into the body, and so our life would, sooner or later, be inevitably destroyed. In lower animals, where the organs of sensation cannot be detected so distinctly as in man, and in some where such organs seem indeed to be completely wanting, there is still an existing faculty equivalent to pain, and followed by similar effects: thus, if we touch the tentacles of a sea-anemone, in which organs we can find no nerve-fibres, the animal instantly withdraws them as if hurt, in the same manner as a dog would withdraw his leg if his foot were pricked with a pin. In the human body, we have three kinds of nerves: viz., the nerves of sensation, the nerves of motion, and the nerves of organic life, which govern the functions of digestion, respiration, secre-

tion, &c. But these three kinds are so intimately connected in the animal economy that one of them may, in certain cases, react upon the others, so that all three are capable of giving rise to pain; the first directly, and the others indirectly, by acting through the first. But happily for us, the study of nature has placed in our possession several means of allaying pain; it has procured us a series of substances which act upon the nervous system so as to deprive it of its faculty of producing pain, sometimes partially, and sometimes most completely, without interfering in any great degree with the other functions of the body.

Some of these means of allaying pain consist in producing sleep, either perfect or partial. The physiology of sleep is little understood, and, indeed, next to life and death, sleep is perhaps the most inexplicable phenomenon inherent to our nature. At certain intervals, we feel an irresistible desire to repose, and sleep comes on gradually. Its influence is felt by certain portions of the nervous system; other portions never sleep. The nerves of organic life continue their functions during sleep, the heart beats, circulation goes on, respiration and digestion continue, but the nerves of motion and of sensation have momentarily lost their power; consciousness is gone, voluntary motion disappears, hunger and thirst are absent, and so likewise is pain. Such is complete or perfect sleep. But it happens sometimes that sleep is partial or imperfect, and then some curious phenomena are observed. Intelligence may be more or less active, and sensation may be possible to a greater or less degree, but never to so great an extent as in the waking state. Generally, in imperfect sleep, consciousness is only partial, volition incomplete, and sensation dull. This state of incomplete sleep gives rise to dreams and to somnambulism. The former are odd manifestations of the intelligence no longer completely conscious. The latter may be either natural or artificial (mesmerism).

In somnambulism the intelligence is more active than in an ordinary dream; the nervous system, only partially subdued by sleep, is capable of bringing into action the senses and motion, but the faculty of feeling pain is almost, if not entirely absent, and moreover the somnambulist has no consciousness of danger. Hence natural somnambulism, which varies in intensity from simple sleep-talking to the most remarkable physical and intellectual feats, is a dangerous condition, inasmuch as we are no longer able to take care of ourselves. However, somnambulists have frequently avoided dangers in the most astonishing manner.

Artificial somnambulism, or mesmerism, as it is sometimes

termed, only differs from the latter in being produced by artificial means. In both cases, the nervous system is more or less subdued as in ordinary sleep; organic functions (respiration, digestion, &c.), continue, but sensation is incomplete or annulled, and the power of feeling pain often completely absent. The manifestations of the intelligence are similar to those in dreams. The somnambulist, whether his sleep be natural or artificially provoked, will generally answer questions that are addressed to him, and in artificial somnambulism, or mesmerism, the intelligence is frequently in an extraordinary state of activity. This activity is, however, never complete; consciousness is absent, and though memory is often remarkably precise, and certain other intellectual faculties acquire, for the time, an extraordinary development, it is absurd to imagine that somnambulists have the power of seeing into the future, &c., as many persons, unaccustomed to the study of physiology, have supposed.

Certain chemical substances have the peculiar property of acting upon the nerves and producing sleep, even when administered in very small doses. These substances act upon the nerves, as is proved by applying them directly upon a nerve, and induce a nervous state, in which no pain, however violent, can be experienced by the person submitted to their influence. They differ by this property from all other known substances. Some of these compounds are extracted from certain vegetables, others are produced artificially in the laboratory. Plants which contain these subtle and powerful agents have been marked by the human race for many centuries, but it was reserved for modern chemistry to extract the active principles themselves, in a pure state, and ascertain their composition and properties. Among these plants are the poppy, the mandrake, the hemp plant, &c.

The mandrake (*Atropa mandragora*) has been used for many centuries to allay pain. Eighteen hundred years ago, Dioscorides stated in his writings, that, in his time, it was given "to cause insensibility to pain in those who were about to undergo any cutting or cauterizing operations." These persons, he tells us, "are thus thrown into a deep sleep, and do not perceive the pain." The Greeks and Romans used the root of the plant steeped in wine. Pliny also mentions the use of the mandrake as possessing powerful narcotic properties, and as being used for injuries inflicted by serpents, as well as for surgical operations, in order to assure insensibility to pain. Apuleius has also spoken of it in a similar manner.

Atropa mandragora, like the *Atropa belladonna* (deadly nightshade), and other plants of the genus *Atropa*, belongs to the family of *Solanceæ*, which contains also the tobacco-plant

(*Nicotiana*), the potato (*Solanum*), and several other important vegetables. It owes its pain-allaying properties to a principle called *Atropine*, a crystalline alkaloid, first discovered in *Atropa belladonna*. Though seldom or ever used at present, the root of the mandrake was frequently employed, with opium and other narcotic drugs, in ages gone by. Theodoric, a pupil of Hugo, who lived in Italy during the latter half of the thirteenth century, gives us, in his work on surgery, the following curious recipe, which shows that he was perfectly aware that surgical operations could be performed without causing any pain to the patient, by employing certain drugs. His indication runs as follows:—"The making of a flavour for performing surgical operations, according to Dominus Hugo:—Take of opium, of juice of unripe mulberry, of hyoscyamus, of the juice of the hemlock [*Cicuta*], of the juice of the leaves of unripe hemlock, of the juice of the wood-ivy, of the juice of the forest mulberry, of the seeds of the lettuce, of the seeds of the dock that hath a large apple [*Datura*], each an ounce; mix all these in a large brazen vessel, and then place in it a new sponge; let the whole boil as long as the sun lasts in dog-days, until the sponge consumes it all. As oft as it is required place this sponge in hot water for an hour, and let it be applied to the nostrils of him who is to be operated upon, until he has fallen asleep, when the operation may be performed."

Here we have opium, the narcotic juice of *Papaver somniferum*, *Hyoscyamus niger*, *Cicuta virosa*, and *Datura stramonium*, together with the less active lettuce, some of the most powerful narcotic vegetables known to us at the present day.

In 1579, Bulleyn, an English writer, described a means of putting patients to sleep, in order to practise the operation of lithotomy. He employed the mandrake. And in 1608, Baptista Porta, in his work on "Natural Magic," gives various receipts for medicines producing insensibility to pain. Among them is one for a "sleeping apple" (*Pomum somniferum*), composed of mandrake, opium, &c., the flavour of which is prescribed to be inhaled by the nose. In the same work it is stated, that certain soporific plants will yield a "quintessence" which will overwhelm one with profound sleep. This is not surprising, when we know that the *Magisterium opii*, an extract of poppy or sort of impure morphia, figured in the Pharmacopœia as early as the seventeenth century.

Of late years, the mandrake has almost completely given way to the deadly nightshade (*Atropa belladonna*), a plant which is well known to have greater power in annulling sensibility than any plant now in use, unless it be the aconite (*Aconitum napellus*).

The plants which contain pain-allaying principles, used at the present day, may be classed as follows:—In the family of Solaneæ, *Atropa belladonna* and *A. mandragora*, *Hyoscyamus niger* (henbane), *Datura stramonium*, *Nicotiana tabacum*; among the Papaveraceæ, *Papaver somniferum*; in the family of Ranunculaceæ, *Aconitum napellus*; among the Compositæ, *Latuca virosa*; in the Scrophularinæ, *Digitalis purpurea* (foxglove); and in the Umbelliferæ, *Conium maculatum*, and *Cicuta virosa*. There are others I shall mention presently.

From all of these, certain active principles, called alkaloids, have been extracted. They have all a most remarkable influence upon the nervous system, and the alkaloids extracted from them constitute some of the most violent poisons with which we are acquainted. Some of them have, moreover, a peculiar action upon the eye; thus, for instance, *Atropa belladonna* causes the pupil to dilate in so extraordinary a manner that it is not difficult to ascertain that a child has eaten the large cherry-like berries of this shrub, when, on approaching a lighted candle close to the eye, we find that the pupil does not contract as usual. Again, *Datura stramonium* (Thorn-apple) is apt to produce blindness for a time when taken in high doses. The calming influence of tobacco (*Nicotiana*) is well known; and headaches cease as if by magic after a short sleep induced by eating lettuce (*Latuca*). Among the mild producers of sleep should be mentioned, also, the hop-plant (*Humulus lupulus*). Pillows stuffed with hops while in flower give repose when others, however soft, have not the power of doing so.

As to opium, the property of the common white poppy (*Papaver somniferum*), as a soother of pain and a giver of sleep, has been known for ages. Opium is the dried juice of the seed-vessels of this plant, and derives its name from the Arab word *Afioum*. Its remarkable virtues are almost entirely owing to the alkaloid called *Morphine*, which it contains, together with a number of other interesting compounds.

The Indian hemp (*Cannabis indica*), which appears to be only a variety of our common hemp (*C. sativa*), possesses medical properties very similar to those of opium. Like the latter, extract of hemp (known as *Haschish*) exhilarates, intoxicates, induces sleep and anæsthesia,* generally followed by headache, nausea, despondency, &c. Hemp was known to the Greeks and Romans, but they were ignorant of its remarkable narcotic and anæsthetic properties. It was used by the Scythians to allay grief and melancholy; they inhaled the fumes given off when the seeds of the plant were thrown upon red-hot stones placed upon the ground in the centre of a closed

* Incapability of feeling pain, &c.

tent. In the East, opium and hemp are smoked or eaten as a luxury, on account of the peculiar intoxication they produce, and people who once become habituated to these dangerous medicines remain slaves to them generally for ever.* The criminals of Barbary endeavour to procure a drug prepared from hemp before undergoing amputation for crime; under the influence of this drug they do not feel the knife of the executioner.† A Chinese physician, Hoa-tho, who lived about 230 years before the Christian era, is said to have used hemp as an anæsthetic in surgical operations. The chemistry of hemp is not yet complete, but its remarkable intoxicating and pain-allaying properties appear to reside in the resin which every part of the plant contains in considerable quantity. The peasants who gather hemp in our climate often complain of headache after being long in the field.

According to Dr. O'Shaughnessy, the hemp-resin will sometimes induce that curious nervous effect known as *Catalepsy*, a condition of the nervous system which few have seen, and which many discredit. It has been once remarked in a patient who had taken a grain of hemp-resin, when his arm was lifted by the physician it remained motionless in that position; and the same occurred with the other limbs, they remained motionless in any position in which they were placed.

Under the influence of hemp, also, all notion of *time* and *space* is apt to vanish completely.

Aconite has been found useful in cases of rheumatism, gout, neuralgia, toothache, &c. It is a powerful medicine, and can only be administered in small quantities; if given in too large a dose, it is apt to produce temporary insanity or death. Its peculiar action on the nervous system is owing to the principle *Aconitine*, by whose virtue it lulls the most excruciating pain, and has been found particularly beneficial in rheumatic complaints.

Opium and hemp are, perhaps, more dangerous substances to deal with than other pain-allaying compounds which I shall mention hereafter. However, in 1774, Ambroise Tranquille Lassard, surgeon to one of the Paris hospitals, recommended the employment of a narcotic such as opium previous to serious and painful operations. And in 1782, Weiss, a pupil of Petit, of Paris, narcotized Augustus, king of Poland, and amputated

* The religion of the Eastern nations forbids the use of wine; hence they have habituated themselves to the use of these intoxicating drugs, which are far more hurtful.

† We all know the tale of the "Old Man of the Mountain;" his followers committed assassination under the influence of hemp preparations which he gave them.

part of the king's foot without his perceiving what was taking place.

In 1784, James Moore, surgeon at St. George's Hospital, London, introduced a plan for lessening pain during operations by compressing the nerves proceeding to the part.

Artificial somnambulism (or Mesmerism), of which I have spoken before, is said to have been used as an anæsthetic agent for the first time in India in the year 1845. Since then it has been applied with considerable success in Europe and America; being first adopted in America, then in France, and afterwards in England. Dr. Esdail, of Perth, who has written a pamphlet upon the subject, brings forward 261 personal observations of surgical cases performed without pain during mesmeric sleep.

The art of mesmerizing often exhausts the strength of the person who induces this state of insensibility in the patient; some patients requiring only three-quarters of an hour, others as much as twenty-four hours' mesmerizing before falling into the somnambulistic state. The process called *Hypnotism*, discovered by the late Dr. Braid of Manchester, appears much simpler than the ordinary method of mesmerizing by the eyes, by passes, and I shall have occasion to refer to it again.

Since the discovery of ether and chloroform, the use of mesmerism to produce anæsthesia appears to be almost abandoned; not so, however, with hypnotism, which seems about to revive.

The discovery of the different gases—carbonic acid gas, in 1756, by Black; oxygen gas, in 1774, by Priestley; nitrous oxide gas, a little later, by the same, &c. &c., gave rise, in England, to the supposition that they might be useful in the treatment of certain diseases, and the system of *Pneumatic medicine* was imagined. This system consisted in causing the different kinds of gases to be inhaled by the patients; it was thought that such a treatment would prove very beneficial in consumption (*Pthisis*). A medical pneumatic institution was accordingly formed at Clifton, near Bristol, by Dr. Beddowes, and huge reservoirs of gases were established for the use of the sufferers. In the year 1799, Humphry Davy, who had just completed his apprenticeship, was appointed the superintendent of this establishment. In the summer of 1800, Davy published some researches on the gas called *nitrous oxide* or "laughing-gas," and on the effects produced when nitrous oxide and other gases are inhaled. He experimented upon himself, and found that nitrous oxide relieved him from headache after a profound fit of intoxication induced purposely by drinking a bottle of wine in eight minutes. After many similar observations, he came to the conclusion that "as nitrous oxide seems capable of destroying physical pain, it may pro-

bably be used with advantage during surgical operations in which no great effusion of blood takes place." This idea had been formed after ten months of continuous and often hazardous experiments. It was on the 16th of April, 1799, that Davy inhaled nitrous oxide for the first time; he states that the introduction of this gas into the lungs was accompanied by a loss of sensation and voluntary motion, but does not recollect what followed.

Nitrous oxide is one of the most remarkable gases with which we are acquainted. It is a transparent, colourless gas, like air, easily prepared by heating nitrate of ammonia; it has a sweetish taste and a faint odour. It has sometimes been called "laughing-gas," on account of its singular property of inducing involuntary laughter in some who inhale it. This gas cannot be breathed for more than a short time, because its peculiar action on the nervous system soon paralyzes the voluntary muscles of the mouth, which, accordingly, cease to grasp the tube of the apparatus, and common air enters the lungs. An animal confined in nitrous oxide gas soon dies after exhibiting symptoms of excitement. When inhaled by man, it first produces a sensation of warmth in the chest, which warmth soon spreads to the extremities, then follows paralysis of the muscles of the mouth, which puts a stop to the further breathing of it. After a short period of quiet or stupor, the patient becomes excited—laughs, sings, dances, &c. In the course of a minute or two, all these effects pass off suddenly, and he returns to full consciousness with a bewildered stare, having no recollection, or a very confused one, of what has passed. It is, in fact, a true case of somnambulism, momentarily produced. But, in some instances, this period of excitement does not manifest itself, or is only of very short duration, and then comes on a kind of stupor and a complete state of anæsthesia. But it is only with patients who are very sensitive to the action of the gas that this state of insensibility to pain can be produced. The late Dr. Gregory, of Edinburgh University, made several experiments with nitrous oxide, by which he has shown that its action upon the economy is precisely similar to that of ether or chloroform, though it cannot be taken by most patients in sufficient quantity (owing to the paralysis of the muscles of the mouth) to procure complete anæsthesia.

Forty years after Davy's experiments, in 1844, Horace Wells, a surgeon-dentist of Connecticut (North America), applied nitrous oxide to tooth-drawing. The first operation was made upon himself; and, when his senses returned, he exclaimed: "This is, indeed, a new era in tooth-drawing!" He afterwards practised this mode of producing anæsthesia for some time, with considerable success. But, unfortunately, in some expe-

riments at Boston, he failed completely, and was most wantonly ridiculed by the ignorant. Wells then abandoned his business; and, in 1848, died by his own hand. In that same year, however, a medical practitioner at Boston, Dr. Bigelow, made some very serious operations whilst the patients were under the influence of nitrous oxide. The inhalations usually occupied about six minutes, and produced complete insensibility.

Such was the state of things when Mr. Morton and Dr. Jackson, of Boston, discovered the anæsthetic properties of a substance then called "*Chloric ether.*" Morton, who had been a pupil of Wells, had already used nitrous oxide; and it was known, as early as 1818, that this "chloric ether," when inhaled, was capable of producing similar effects to those of nitrous oxide. Thinking that "chloric ether" could be more easily administered than the gas, Morton made an experiment to this effect upon himself, on the 30th of September, 1846, and succeeding in rendering himself completely unconscious for eight or nine minutes. He soon afterwards extracted teeth from patients placed under the influence of this new anæsthetic; and, on the 16th of October, 1846, he administered the volatile liquid to patients about to undergo surgical operations, in the Massachusetts General Hospital.

Morton withheld his discovery, calling the sleep-producing substance "Letheon;" but its peculiar odour led Dr. Bigelow to try the effects of common ether (sulphuric ether), and, finding that it acted precisely like the "Letheon," he immediately made known his discovery. The American papers, however, criticised it unjustly for some time; but all the absurdities asserted against this valuable discovery were exposed when Dr. Bigelow published his work "On Ether and Chloroform," in 1848.

In London, ether was soon experimented with by Dr. Booth, Mr. Liston, and several others. Professor Simpson was at this time in London, and, procuring one of the best inhaling apparatus, he proceeded to Edinburgh, where he employed ether in the treatment of *accouchements*. Soon after this, Drs. Velpeau and Roux informed the Academy of Medicine at Paris that the discovery of the anæsthetic properties of ether was a glorious conquest for humanity.

Thus ether,—which was known to Raymond Lully in the thirteenth century, and to Basil Valentine in the fifteenth, and which Valerius Cordus carefully described how to make, in 1540, calling it *Oleum Vitrioli dulce*,—was only applied to produce insensibility to pain about the middle of the nineteenth century.

It is, perhaps, as curious that the so-called "chloric ether,"

mentioned above, was nothing less than impure *chloroform*. Mr. Jacob Bell, of London, it appears, was the first to procure it in a pure state, and demonstrated anew its wonderful anæsthetic properties. As early as 1831, Dr. Gutherie, an American chemist, had shown that this substance is procured when spirit of wine is distilled with chloride of lime. But its true chemical composition, which had puzzled Professors Silliman, Liebig, and Soubeiran, was finally determined by Professor Dumas, of Paris, in 1832.

On the 8th of March, 1847, M. Flourens stated, at the Paris Academy of Sciences, that he had experimented with chloroform upon different animals, and had ascertained that it invariably produced insensibility; but he concluded that its action was too dangerous to be applied to man. However, in November of the same year, Professor Simpson, of Edinburgh, applied chloroform, for the first time, to annul the pains of labour, and it has since completely dethroned ether in surgical operations.*

Dr. Gregory, of Edinburgh, afterwards showed that the action of ether and chloroform is precisely similar to that of nitrous oxide gas. When either of the two former is inhaled in insufficient quantity, the patients are given to laughing, dancing, &c., as if they had respired a dose of "laughing-gas."

It is certainly wonderful, when we reflect upon the fact, that these volatile liquids, whilst rendering us insensible to pain, cause the patient to experience pleasant sensations whilst under the knife of the surgeon. Before referring to any other means of rendering man insensible to suffering, let us take a rapid glance at the manner in which these remarkable anæsthetics act upon the system.

Under the influence of chloroform and ether, the nervous centres lose their powers in regular succession. This is not only an interesting physiological fact, but also a practical point of great importance. First, the cerebral lobes lose their influence, and consciousness disappears entirely. Next, the cerebellum loses its power of regulating locomotion. Next, the spinal cord becomes incapable of producing sensation and of originating motion; but the *medulla oblongata* (that portion of the spinal cord which enters the brain), which presides over respiration, still retains its functions. Next, the *medulla oblongata* is affected; when this occurs breathing ceases, and

* Ether has often been applied with success to subdue intoxication by wine, as we see the betel-nut employed by the Eastern princes to dispel the effects of *haschish*; after inhaling a little ether vapour, the intoxicated person generally recovers his senses. Ammonia acts in a similar manner.

death is near; but, even yet, the ganglionic nerves of the sympathetic system perform their functions, and the heart and intestines continue to move for a time, often with vigour.

It is thus seen that when anæsthetic vapours are inhaled the different nervous centres lose their powers in the *inverse* order to their *essentialness* to life; the functions of the sympathetic nerves ceasing last of all, and the heart and womb retaining for a time, therefore, their contractile power during states of anæsthesia, so deep as not only to involve the annihilation of consciousness and sensibility, but also of respiration. In order to render a patient insensible to the most severe surgical operations, it is never necessary to proceed further than the third stage of anæsthesia; in child-birth still less is required, and the patient may be kept on the borders of consciousness, or be conscious even during the whole time.

Here, then, in a few words, is the explanation of these wonderful phenomena.

In the human body exist, as I stated before, different systems of nerves, and the art of producing anæsthesia consists in allowing one system to work as usual whilst the other systems are under the influence of sleep. The nerves of motion and of sensibility are made to sleep, whilst the nerves of organic life continue their functions. We are now enabled to appreciate these wonderful discoveries, and to admire the marvellous arrangement of the nervous system. The problem of depriving man of sensibility and motion, without impeding respiration, circulation, digestion, or, in other terms, of depriving him of his faculty of moving and of feeling pain, without depriving him of life, has been solved. During anæsthesia, then, man lives like a plant—his animal faculties are taken from him for a time.

Since the discovery of chloroform, several substances have been found to have a similar wonderful action upon the nervous system. Among them are two chemical products, called *Amylen* and *Acetone*.

Amylen, a peculiar volatile liquid, obtained from impure potato spirit, was first administered by Dr. Snow, at King's College Hospital, London, in November, 1846; and he continued to use it until July, 1857. During this period, 238 persons were operated upon during anæsthesia produced by amylen, out of which number only two deaths occurred. It was afterwards used in France; but I do not know that it possesses any advantage over chloroform.

In 1859, Dr. Kidd proposed the use of Acetone (a volatile liquid, produced by distilling acetate of lime, and which has long been known to chemists) as a powerful anæsthetic. Its agreeable odour, which resembled somewhat essence of mint

or of quince, appeared to recommend it. Its anæsthetic action is less durable than that of chloroform, but, at the same time, it acts very rapidly. Its principal advantage was stated to reside in the fact that it can be mixed with water in any proportion, so that the dose can be regulated at will; it can, moreover, be employed in damp, warm sponges, and is not liable to decompose by keeping.

Of late years, *cold* has been applied in some cases to induce local anæsthesia. Dr. John Arnold has advocated the induction of insensibility by freezing the part to be operated upon. This is based upon the fact that the nerves of sensibility cannot perform their functions below a certain temperature. Thus it is that travellers on the summits of high mountains or in the Arctic regions are apt to lose their noses, the nerves of the frost-bitten part being benumbed by the cold; gangrene sets in without the sufferer being aware of it.

Local anæsthesia has also been produced by the simultaneous actions of electricity and a narcotic. Some experiments were made upon this subject by Dr. Richardson, in 1859. This method of proceeding is very simple:—Upon the part to be operated a powerful narcotic is applied, and upon the narcotic mixture is placed a flat metallic disc communicating with the positive pole of a Bunsen's or Grove's battery; the negative pole being applied to some other portion of the patient's body, at a convenient distance from the other pole. The battery being put in action, that part of the patient's body comprised between the two poles soon becomes insensible to pain.

Dr. Richardson has also made the curious discovery that the fumes emitted by burning the common Puff-ball Fungus (*Lycoperdon proteus*), when inhaled, produce anæsthesia in a similar manner to chloroform and ether. The fumes of this fungus have been for some time employed with advantage to stupefy bees before taking their honey; it causes no injury to these useful insects. This fact probably led Dr. Richardson to try its effects upon other animals, and, lastly, upon man; when he arrived at the conclusion that the fumes given off by the common puff-ball, when this fungus is burnt upon a hot shovel, possess anæsthetic properties in a high degree.

Carbonic acid gas has been shown quite recently, by Dr. Ozanam, of Paris, to be capable of inducing anæsthesia like chloroform, &c. Indeed, its peculiar stupefying action is frequently experienced by the French cooks, in whose kitchens wood-charcoal is used in small open grates; and by the inmates of counting-houses and warehouses, where ventilation is generally bad. The effects of this deleterious gas upon dogs is frequently shown to travellers near Naples in the *grotto del Cane*, a cavern where a large quantity of carbonic gas issues

from the earth, and from its weight, much greater than that of air, forms a thick stratum of suffocating gas upon the floor of the cavern. When a man enters, his head and shoulders rise above the stratum of gas, and he breathes pure air; but when a dog is introduced, his head and body plunge completely into the carbonic acid gas, and he soon falls down, suffocated. The animal is then removed by the guide, laid upon the grass outside, and, in a short time, recovers.

Dr. Ozanam has shown that this suffocation by carbonic acid, when produced properly, affects a patient like chloroform, ether, or nitrous oxide, and can be made available in surgical operations. Indeed, he considers that carbonic acid has certain advantages over chloroform, and that it is less dangerous than the latter.

But of all the means hitherto employed to render man perfectly insensible to pain, the most curious, perhaps, is that called *Hypnotism* or *Braidism*, discovered many years ago by the late Dr. Braid, of Manchester, and practised successfully by him in England. It consists in placing some object, such as a cork or a piece of polished metal, at a short distance from the forehead of the patient, and requesting him to fix his eyes steadfastly upon it. After some time, which varies from a few minutes to half an hour or so, according to the constitution of the individual, the patient's eyes seem riveted upon the object in question, and for some moments he remains thus, without once closing them; they then suddenly close, and the patient falls into what is termed the hypnotic state, a kind of somnambulism similar to mesmerism. Consciousness has disappeared, and complete insensibility to pain has ensued.

Braid's discovery seems to have been abandoned for some time past by the medical world, but was occasionally put in practice by lecturers on the so-called "electro-biology," &c. Lately, however, it has been taken up again in Paris, by M. Paul Broca, surgeon to one of the hospitals of that city; and Dr. Braid just lived long enough to hear of his method of producing anæsthesia meeting with singular success in the hands of M. Broca. One of the first results obtained by the latter was made known a year or so ago at the *Académie de Médecine*. It was the case of a woman who had repeatedly refused to be operated upon for a large tumour. At length, M. Broca induced anæsthesia by causing the patient to fix her eyes upon a metallic disc which he held above her forehead. In about a quarter of an hour, a state of complete insensibility supervened, and the operation was performed. On returning to her senses, the poor woman would not believe that the operation had indeed taken place whilst she was under the influence of sleep.

BARMOUTH.

BY THE EDITOR.

"VACATION TOURISTS" make it their business, once a year, to strain every nerve in order to reach the remotest corners of the earth, to visit some unexplored or imperfectly-known region, and accomplish the journey home, during the period called "the vacation." That the last is a somewhat indefinite term is obvious, from the fact that it enables one gentleman to set foot on the Fiji Islands; another, to admire the scenery of the river Amazon; a third, to compass a nine weeks' tour in Canada; and a fourth, to sun himself on the banks of the Niger, and in other portions of tropical Africa! How these feats can be accomplished within a period which we have usually supposed to be limited to five or six weeks, we are at a loss to understand, and it is not our business to institute an inquiry; but, however it may be managed, we fear that, after the revelations of those hardy travellers who brave the perils of the ocean wilds and mountain avalanches, the burning desert and the knife of the savage, in order to serve up a palatable dish of adventures for their readers at home; after a perusal of the narratives of these bold adventurers, we say, there can be little hope that our readers will find much to interest them in the few notes taken during a "vacation tour in Wales," comprising a sojourn of ten or twelve days at a quiet little fishing town, and a series of short excursions in its vicinity.

We shall take courage notwithstanding; conscious that if we are unable to satisfy that craving after the marvellous, which can only be appeased by stories of hair-breadth escapes from such dangers as we have just referred to, yet we have the advantage of being able to direct the attention of our readers to scenes of beauty and interest lying at their own doors, and to speak to them of pleasures, in every way rational and desirable, which they may themselves enjoy, instead of receiving them, with or without modifications, at the hands of others, and participating in them only in imagination. For it matters little to what class or section of society the reader belongs; be he rich or poor, sick, careworn, or ripe for sport

and adventure; be he angler, botanist, conchologist, geologist, palæontologist, pteridologist, ornithologist; indeed, if he be devoted to any or many branches of science, commencing with archæology and ending with zoology—or only a lover of the grand and beautiful in Nature—he may indulge to the full in his favourite pursuit within ten miles of the modest little fishing town which forms the subject of these pages.

The archæologist will find relics of antiquity connected with every period of past history. In the town itself is an old building, rendered interesting by its association with incidents in English history in the fifteenth century.

Llanaber Church, a beautiful little edifice, distant about two miles from Barmouth, and still used for divine worship, is supposed to have been built about the thirteenth century, and abounds in features of archæological interest; so, also, does the old Elizabethan mansion of Cors-y-gedol, about five miles distant. These, along with Harlech Castle, Cymmer Abbey, &c., are associated with the history and habits of the Middle Ages; whilst there is hardly a lake, stream, or mountain slope which does not, either by traditions connected with it or actual remains, carry the tourist back to the Roman occupation, the Druidical age, or to the still more remote eras of mythology.

So much for the archæologist, now for the botanist.

Does he desire to study and collect wild flowers? Then, we may venture to promise him (without at all referring to their glowing colours, which rivet the attention of the traveller so that he can barely find time to admire the grandeur of the surrounding scenery) that he will meet with numbers and variety in the valleys, on the hills, or by the wayside, which will serve to occupy his attention during many a protracted ramble. Forest-trees he will also find in great diversity and splendour; whilst of ferns, mosses, lichens, fungi, &c., the name is legion; and many ferns present themselves of extreme rarity.

Of all these plants a list, prepared by a talented botanist in the neighbourhood,* has been appended to the little handbook before us;† and there are few localities, in England or elsewhere, which yield such treasures of plant-life as do these hills and valleys and rugged cliffs.

The marine zoologist will meet but little to interest him on the shores of Cardigan Bay, at least not within a convenient walking distance of Barmouth; but the ornithologist and ento-

* Mr. J. Pughe, F.R.C.S., Aberdovey.

† The printed "Guide to Barmouth" is published by Mr. D. Jones, Bookseller, Barmouth. The most experienced guide living at Barmouth is a person called Hugh Richards—a good sportsman and a useful companion to the archæologist.

mologist will find, both on the shores and inland, many interesting birds and insects.

To the shell-collector more especially, is this a locality of deep interest, for, about seven miles from Barmouth, in the direction of Harlech, there is a small tongue of land jutting into the sea, called Mochres, where shells of great rarity, both univalve and bivalve, are to be met with on the beach at low water, more particularly after tempestuous weather.*

And now, what have we for the geologist and mineralogist? Judging from the ecstasies of two learned professors from the metropolis, with whom we journeyed a few miles through this lovely district, as well as from our own observation, we should say that there are few parts of Britain which afford so many opportunities for the study of these subjects as do the hills and rocks of this neighbourhood.

The following extracts concerning the geology of Cader Idris will convey to the reader some idea of the varied character of the strata in this district:—

"Geology.—It consists of silicious porphyry, quartz, and schorl, and is surrounded by slaty hills. Evidences of the volcanic character of the mountain are abundant. Numerous specimens of lava, pumice, and other volcanic products, have been discovered on the sides and base of the mountain. Columnar crystals of basalt are scattered in profusion about the summit and on some of the inferior cliffs, and particularly on one side, there are vast beds of porous stone, bearing evident marks of strong ignition and vitrification—some reduced to the state of slag, and others having the cellular appearance and lightness of pumice."—*Black's Guide*, p. 121.

"The slope of Cader, on the Talyllyn side, above Llynycae, is an igneous rock, principally composed of amygdaloidal green-stone, and under are masses of felspathic trap and long lines of green-stone, interbedded with altered slate, forming the steep north cliff of the mountain, and overlooking the high valley between the cliff and Llynygader, which itself is formed almost entirely of felspathic ash and conglomerate, with interbedded lines of green-stone—the whole dipping under the igneous rocks of the cliffs. Lingular flags underlie these."—*Ramsay.*

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* For the guidance of conchologists visiting this interesting locality, we may add that Mochres may be approached from two points, namely, from Llanduwe, a church and inn, situated rather over four miles on the road from Barmouth to Harlech, or from Llanbedr, a considerable village, three or four miles nearer to Harlech, on the same road. Although a little may be saved in the distance, by approaching it from the first-named place, yet, on account of the tedious walk across a dreary moor which must be traversed, as well as the difficulty sometimes experienced in crossing to Mochres from the mainland by this route, we strongly recommend the tourist to proceed along the beautiful coast-road to the village last-named (Llanbedr), which is close to the peninsula, and from which he may reach the shell-covered beach in a few minutes without any difficulty.

Amongst the numerous mineral products extracted from the soil in various parts of the neighbourhood, the most conspicuous are slate, copper, lead, and gold; and, as reference has already been made to the last-named precious metal in a recent number of this periodical, we shall now add a few details on the subject, which may, perhaps, be interesting to our readers.

In his paper on the Gold Mines of this district, our contributor more than once mentioned the name of Mr. Readwin, to whose enterprise and scientific knowledge this country is indebted for the new mine of wealth which is being laid open in these our home-diggings.*

During our recent visit, we were so fortunate as to meet that gentleman, who is largely interested in several of the most important mines in the neighbourhood; and one of these, the Garthgill mine, we were permitted, through his kindness, to inspect.

Let us narrate the details of our visit.

Having received a note from Mr. Readwin, stating that he would be at the Garthgill mine, which is situated about half-way between Barmouth and Dolgelly, not far from the coach-road, between one and two o'clock in the afternoon, we started from the former place on a magnificent July morning, at about half-past eleven; and, after a smart five-mile walk, arrived at the "Halfway House," a little roadside inn, at a place called Pont Ddu, which is distant about one mile from the workings of the Garthgill mine.

A word *en passant* concerning this same walk of five miles. The road runs along the northern bank of the river, or, more properly speaking, the estuary of the Mawddach, deviating slightly, here and there, from the upward course of the stream; and, although we have visited many a beautiful scene, in Britain as well as abroad, we must confess that we have never met with anything to surpass this one. We see it before us in imagination as we write. Facing us, through a break in the trees, are the towering heights of Cader, on the opposite side of the river. To the right we have the boundless expanse of ocean peering through the bold headlands at the mouth of the estuary. To the left, the Mawddach, vying in beauty with the choicest portions of the Rhine, and presenting the appearance of a series of beautiful lakes through the windings of the stream amongst the mountains; whilst on all sides are ranges of hills, the slopes of some being fertile meadows, others bare, rugged, and precipitous, and others, again, concealed from the

* "The English California," by G. P. Bevan. No. IV. POPULAR SCIENCE REVIEW.

eye by the plantations of pine and fir, reaching from base to summit.

By the wayside are walls and hedges glowing with all the colours of the rainbow. Foxgloves of intense purple, wild roses of the deepest pink, with here and there wild geraniums, wild strawberries, and rasps; and as to the ferns, we feel, when we stoop to pluck a frond, to be used for driving off the troublesome flies, as though we were committing a desecration upon nature, in thus deforming the graceful cluster which shoots its arching stems on every side.

But we must quit this lovely scene, only, however, to approach another almost as beautiful. Having partaken of luncheon at the "Half-way House," a meal rendered most enjoyable by the healthful exercise of a rapid walk amongst these glorious scenes, we hastened onwards, and soon arrived at a large water-wheel, a mile beyond Pont Ddu, which is used for grinding the copper ore extracted from a neighbouring mine. Here we diverged from the main road, and, under the guidance of a blacksmith, who has a smithy hard by, and who was unable to speak a word of "Sassenach" (Saxon, or English), whilst we are equally well versed in "Cymraeg" (Cambrian, or Welsh), we found the "engine-house" of the Garthgill Mine. And here another beautiful scene presented itself to our gaze.

In the mining districts, the "Black Country" of Northumberland, Lancashire, and Staffordshire, nature appears to don sackcloth and ashes; to mourn, as it were, over the robberies hourly perpetrated in her domains. But here, amongst these lovely hills, she welcomes the enterprising miner, and tempts him to commence his operations by laying her treasures at his feet, and holding out to him every inducement that her charms can afford.

On the one hand, we find nought but smoke and arid desolation; and, if some unsuspecting plant, some blade of grass or tender floweret, should venture to extrude itself above the surface, the noxious gases of the furnace, factory, or mine, at once deprive it of its tints, and cause it soon to droop and die for very shame. Here, on the other hand, the elements and nature co-operate with man. The rushing waterfall, bubbling and gurgling amongst the rocks, stops in its headlong course, and, flowing gently through an artificial duct, assists to turn the wheel, and work the pestles of the miner; whilst the clear stream below serves at once to slake his thirst, to lave and cool his heated brow, and cleanse his ore from dross and from impurities.

'Twas such a scene as this that we encountered here.

From the "engine-house" (to be presently described), we continued to climb up the hill, accompanied now by the over-

looker of the mine, and, after traversing a beautiful meadow on the mountain slope, where they were busy getting in the hay, and passing more than one working, at which operations had just been commenced, we suddenly found ourselves before the chief working or lode; not a very imposing, but still an interesting, excavation.

It is a small tunnel driven into the hill-side. Its height is about eight or ten feet, and its width barely five; and at the entrance we found several heaps of the auriferous quartz.

Entering the tunnel, we observed that the superincumbent rock and earth were supported by props and joists of wood; and, after penetrating about twenty or thirty yards, we found ourselves with the miners, who were busily engaged with pick-axe and gunpowder, procuring the gold-charged mineral, which, by the light of their candles, glistens with the precious metal it contains.

But it is a cold, damp burrow, this treasure-yielding vault! Through the grey rock the wet trickles as in some cave of stalactite, and under-foot we find a pool of water.

The miners had just finished procuring a load of the quartz, and were boring for a fresh blast. After watching them for a time, we retraced our steps, and once more emerged from the damp chill cavern into the genial sunshine, and feasted our eyes upon the glorious hills and valleys of the Mawddach.

Arrived once more at the "engine-house," a little wooden shed containing the apparatus used for grinding the quartz, we met the enterprising owner of the mine, who described to us the process and machinery by which the precious metal is extracted from the crude mineral.

We shall, however, refrain from employing the technical phraseology used by our instructor, but shall seek to convey the information after our own fashion.

Just let the reader join us whilst we indulge in a stretch of the imagination. He must suppose that our skilful companion, the proprietor of the mine, who knows so well how to conjure up the treasures from the bosom of these hills, is also able, through some potent spell, to summon the presiding Genius of the place (one of those Welsh giants, in whom the country people still believe, and whose footsteps they will show you, thirty feet apart*), and having done so, places before him a pestle and mortar, of proportions suited to his strength, and by his side a heap of auriferous quartz, with a quantity of quicksilver, bidding

* On the coach-road between Beddgelert and Carnarvon, the impress of one of the feet of a giant has been painted on the top of a rock on one side of the road, and that of the other foot on the opposite side, distant about thirty feet.

him grind the ore, whilst an attendant sprite is pouring a continuous stream of water on the triturated mass.

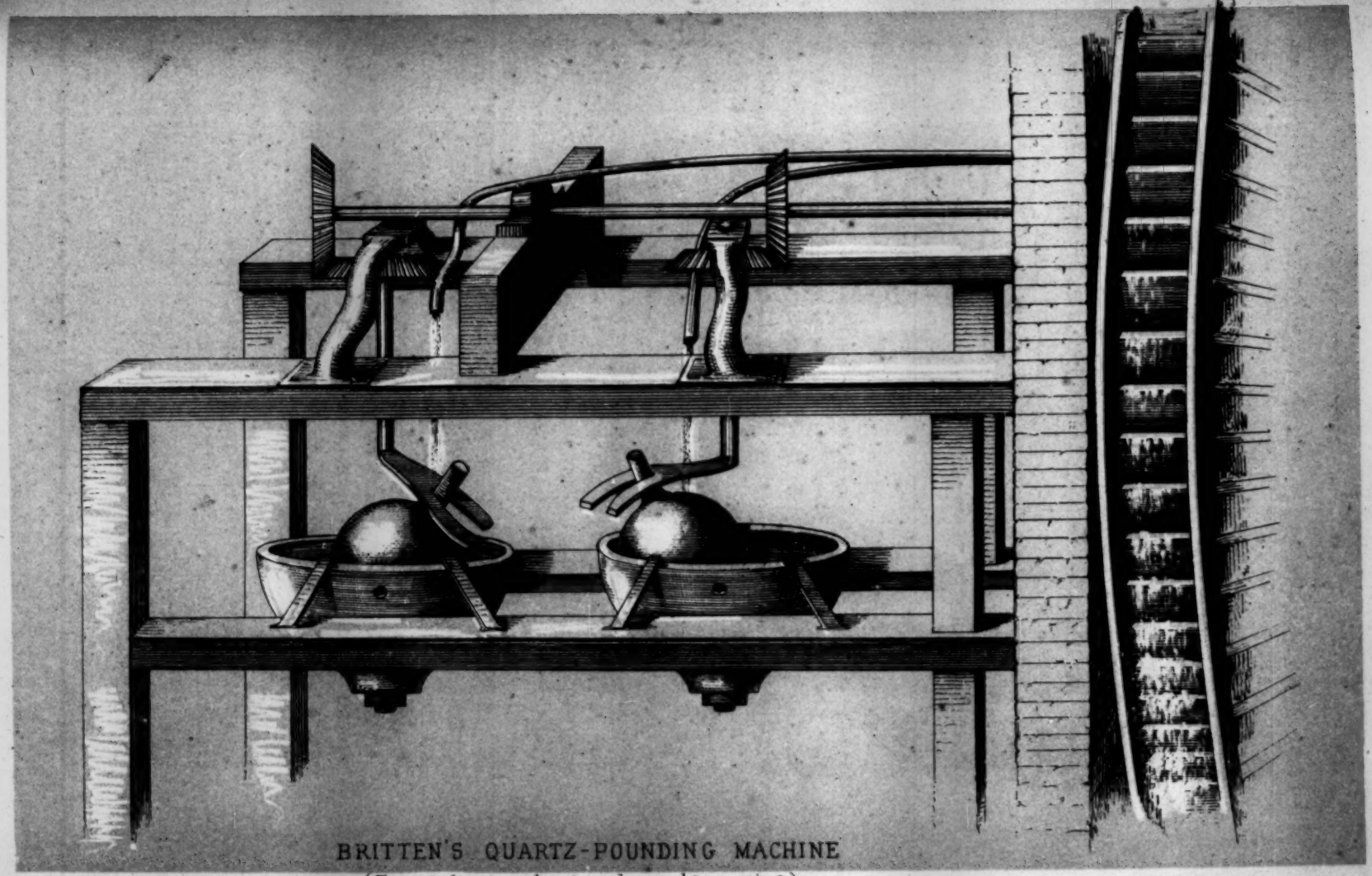
This is really what Mr. Readwin has contrived to do.

His "Genius" is the lovely waterfall which excited our admiration, and which is formed by the stream as it flows past the engine-house.

Causing a portion of the water to diverge, he lets it flow along a wooden conduit that leads it to a little water-wheel, which is thus set in motion. This wheel turns a horizontal shaft or axle in the engine-shed, and, by means of two vertical cog-wheels attached to the shaft, and two other horizontal ones, into which these work, two smaller vertical shafts are set in motion, and to these are affixed the arms, which cause the grinders or pestles to revolve in the mortars containing the quartz. This is effected much after the manner in which a druggist's apprentice pounds drugs with a large pestle and mortar. The arms attached to the vertical shaft are of iron, and the reader may form an idea of their shape and mode of operation, if he turns the palm of his hands downwards, doubling his thumb and two last fingers underneath, protrudes his first and second fingers, and slightly separates them, lowering the points. These two fingers will then represent the "arms." Let him now suppose that his fingers can be made to revolve horizontally, and that they carry round with them a pestle, which is held between them, but allowed to roll freely against the sides of a mortar, in which it works, and he will thus imitate the grinding or pounding process here employed. (See Plate IV.) The pestle is shaped like a peg-top, with the pointed end downwards, and weighs about 2 cwt.; and the mortar is a vessel of cast iron, of proportionate size and strength; of a suitable form internally, and externally a hemisphere. The quartz is first broken as fine as the hammer can reduce it. It is then placed, along with mercury, in the mortar, and a little stream of water is allowed to trickle continually through a siphon upon the triturated mass. The gold contained in the quartz is taken up by the mercury as the trituration proceeds, and a lump of amalgam sinks to the bottom of the mortar, and is taken out through an opening closed by a plug. It is heated in an iron retort over a furnace, the mercury driven off, and the residue is pure gold, worth about £3 an ounce.

In some cases, the gold is visible in the quartz, and Mr. Readwin showed us a piece of the latter, so charged with it, that he valued it (the crude mineral) at £1,200 per ton; in others, it is scarcely to be detected with the aid of a pocket-lens, being disseminated in fine granules throughout the matrix.

There are other processes by which the gold is extracted



BRITTEN'S QUARTZ-POUNDING MACHINE

(For grinding, washing and amalgamating)

Sketched at Garthgill by J.S.

W West Lith

Plate IV.

from the quartz on these hills, but this one appeared to us so simple that we describe it in preference to any other for the benefit of our readers, who must permit us now to conclude our visit to the gold-mine, and will, we hope, return with us, more expeditiously than we came, to the centre of our excursions—Barmouth.*

Enough has, we trust, been said to show that this place and its vicinity abound in features of interest to the man of science, and a great deal more might be added to the same effect; but, possibly, there may be amongst our readers some who would feel a desire to visit it, as we did, for relaxation and rest from those very pursuits which may be here so successfully followed; and to such we will, therefore, address a few words in conclusion.

This quiet little fishing town, nay, we need not hesitate to call it village, for it contains at present only 1,200 inhabitants, certainly offers no attractions to the man or woman of fashion. There is no promenade except the beach extending for miles round Cardigan Bay; no Spa; no morning or evening dress.

If the frequenter of the parks or ball-rooms of the city desire to meet fashionably-attired ladies, we advise him to seek these and similar attractions at Scarbro', Brighton, or some other equally fashionable and well-frequented watering-place, but not to embarrass and disturb the tranquillity of the students, artists, and overworked men of business, who take refuge here, with their wives and children, from the noise and bustle of the busy, struggling world; and who, bringing with them their oldest garments, wear out these instead of the bodily frame which they cover; and take away with them

* The account here given of the gold-extracting process is necessarily imperfect and superficial; but such of our readers as desire more detailed information, on that and kindred subjects, are referred to the following printed papers:—

"On the Occurrence of Gold in Merionethshire," by T. A. Readwin, F.G.S. Read before the British Association, 1861. Published by A. Ireland & Co., "Examiner" Office, Manchester.

"The Gold Discoveries in Merionethshire, and a Mode for its Economic Extraction," by T. A. Readwin, F.G.S. Same publishers.

"List of Gold Ores from Merionethshire," exhibited at the International Exhibition, 1862. With detailed description, by T. A. Readwin. Same publishers.

"The Geological Structure of Merionethshire and Caernarvonshire," by Professor Ramsay, F.R.S., &c. Reynolds & Co., London.

The *Manchester Examiner and Times*, of Tuesday, July 29, 1862.

Mr. Readwin informs us that *two* such machines as we have described and sketched are in constant use at a mine near the "Garthgill" (the Clogau), and that they extract *weekly* 140 ounces of gold from 7 cwt. of quartz.

bronzed faces, fresh roses in their cheeks, an increase of corporeal substance, light hearts, and renovated spirits to enable them to enter once more into the battle of life.

If, however, there be any one who can admire a quaint little seaport town, standing on the sea-beach, at the foot and on the incline of a precipitous rock whose summit may be 1,000 feet above the sea-level; a town consisting of neat grey stone houses, so built upon the precipitous cliff that the inhabitants of one set of houses look over the chimneys of another row beneath;—if he can find enjoyment in rambling five or six (or as many more) miles along the broad sands or beautiful coast road which extends in either direction along the Bay of Cardigan; can appreciate a sail, row, or ramble amongst the hills and valleys, and wishes to realize the beauties of the Rhine without quitting his native land, or, lastly, if he can rouse himself sufficiently to scale the sides of glorious Cader, as we did one fine summer afternoon, rambling by the way through wooded glens, rich in trees and ferns and flowering shrubs, and by the side of rushing waterfalls, climbing rugged steeps, sweeping round magnificent hill-sides, stopping to ponder over the vestiges of ancient rule in Britain—man's handiwork—or to admire the grand operations of Nature as exhibited in volcanic action, in pumice and heaps of slag-like stones and columnar basalt set on end in architectural order, treading elastic heath and breathing its invigorating atmosphere; if he can find delight in a constantly-extending landscape, hill after hill, lake after lake, town after town opening to the sight; clouds spread out like a sea beneath, or sweeping past him like volumes of smoke from a cannon's mouth, or floating gently, as snowy fleeces, overhead, until at length he has risen so high above the earth that he appears to have reached some new celestial region, from which all beneath looks small and insignificant, whilst the beholder feels himself raised high above all earthly passions and sensations;—if, we say, any of our readers can appreciate such delights as these, then let them speculate upon and anticipate now, visit and enjoy hereafter, and recollect, as we shall do, with life-long remembrance, a vacation trip in North Wales, a sojourn at the little town of Barmouth, at the entrance of the river Mawddach, in Merionethshire, and many a pleasant health-reviving ramble through its valleys and across its mountain ranges.

ON THE APPLICATION OF SCIENCE TO ELECTRO-PLATE MANUFACTURES.

PART II.

THE success of an important enterprise has frequently depended upon an apparently trivial circumstance, and it was even so with the important process of silver electro-plating in the early period of its development. In the year 1838, Messrs. G. R. & H. Elkington were engaged, commercially, in coating military and other metal ornaments with gold and silver, by immersing them in various solutions of those metals, some of which were composed of ferrocyanide of potassium, and also carbonate of potash, with the oxides of gold and silver dissolved in them.

By this process of simple immersion, although the action was electrical, the articles received only an extremely thin film or coating of the precious metals, and it was highly desirable that the thickness should be considerably increased, on account of the greater degree of durability required.

About this period, Professor Jacobi, of St. Petersburg (October, 1838), and Mr. Spencer, of Liverpool (May, 1839), published their processes of electrotype for copying engraved plates in copper by separate currents of electricity, by means of which a firm coating of copper, of considerable thickness, could be readily obtained. From the moment that this method of obtaining *thick* deposits of firm copper by means of a *separate* electric current was made known, Mr. John Wright, a surgeon of Birmingham, and Mr. Alexander Parkes, a modeller and experimentalist, in the employ of Messrs. Elkington, were constantly engaged in experiments, to obtain thick deposits of silver and gold by similar means. A great variety of liquids were tried for the purpose, but all the solutions of gold and silver operated upon gave only a thin deposit of firm metal, which, as it increased in thickness, became loose in aggregation, and assumed the character of a dark-coloured or black metallic powder, completely useless for the purpose required.

At this particular juncture, Mr. Wright met with the following passage in Scheele's "Chemical Essay" (pages 405 and 406). Speaking of the solubility of the oxides and cyanides of gold,

silver, and copper, it says, that "if after these calces" (*i. e.*, the cyanides or ferrocyanides of gold and silver) "have been precipitated, a sufficient quantity of precipitating liquor be added, in order to redissolve them, the solution remains clear in the open air, and in this state the aerial acid" (*i. e.*, the carbonic acid of the atmosphere) "does not precipitate the metallic calx."

This liquid, "the precipitating liquor," is obtained by burning dried blood with potash in an iron vessel, cooling the melted product, and dissolving out its soluble portion by water; the resulting solution contains cyanide and ferrocyanide of potassium, the latter of which is commonly known as "yellow prussiate of potash."

Mr. Wright had been working during several months, expressly to obtain a thick deposit of silver, with the aid of a separate electric current, before he met with the above passage. He then took a solution composed of chloride of silver, dissolved in an aqueous solution of ferrocyanide of potassium, and succeeded in obtaining what had never been obtained before,—a *thick* deposit or coating of *firm* silver by electrolytic action.

The first article that received the successful coating was a small vase, which was coated at Mr. Wright's residence, and the next was a figure of a small kid. The mode of proceeding adopted by him in these cases, was to place the article in the silver solution contained in a porous vessel (a common garden-pot), immerse the porous cell in an outer vessel containing dilute sulphuric acid, place a cylinder of sheet-zinc around the porous vessel in the dilute acid, and connect it by means of a copper wire with the article to be coated; the electrical action then commenced, and the article gradually acquired a thick coating of silver: this method is commonly known as the "single cell" process.* It was about a month after this when a solution of actual cyanide of silver and potassium, the substance now universally used for electroplating, was first employed by Mr. Wright for the purpose, although cyanides, in several forms, had been used both for coppering and silvering by simple immersion, without the aid of a battery or zinc, about sixteen months previously.

The above-mentioned successful results were immediately submitted to Messrs. Elkington, who made arrangements with Mr. Wright for the security of the discovery and invention, and patented it on March 25th, 1840; this patent was the basis of all successful electro-silver-plating and gilding. A handsome remuneration was made to Mr. Wright by this firm for his invention, and an annuity paid to his widow (afterwards

* See Plate V. fig. 1, and explanation at end of article.

the wife of Mr. Cammell, of Sheffield), after his death. A separate battery, to generate the electric current, was not employed until January, 1841, nearly a year after the date of the patent; and, in the early stages of the process, the silver solution was employed hot; now it is always used cold. Nickel silver was always the substance employed as a base for receiving the deposit from the earliest period of electro-silver-plating, or at least soon after the date of Mr. Wright's patent. The edges of articles are made of the best quality of nickel silver, which is very white and very hard, suitable for resisting friction, whilst the body part, or mass of the article, is made of a commoner quality, not only because it is less expensive, but also because it is worked more easily.

Electro-deposition of the precious metals was *theoretically* accomplished long before cyanide of potassium was known; as early as the year 1805, Brugnatelli "gilt, in a complete manner, two large silver medals, by bringing them into communication, by means of a steel wire, with the negative pole of a voltaic pile, and keeping them, one after the other, immersed in ammoniuret of gold, newly made and well saturated." We should therefore not condemn theoretical science, because we are not able, even with fair and persevering trial, to apply it to any useful purpose, but *wait patiently* until circumstances ripen for its application. Many discoveries and inventions which are inapplicable in one state of knowledge, become applicable by the progress of science and art; the idea of electro-gilding, first attempted in 1805, by means of a solution of ammoniuret of gold, had to await the discovery of cyanide of potassium, in 1815, before it could be practically applied; and the idea of an electric telegraph, first attempted by the aid of frictional electricity, had to abide the development of the voltaic battery, and the discovery of electro-magnetism, before it could be successfully carried out.

A great number of experiments had to be made, and many serious difficulties to be surmounted, before practical and remunerative electro-plating was an accomplished fact. One of the chief difficulties consisted in making the silver adhere firmly to all parts of the underlying metal; this want of adhesion arose partly from the employment of too many cells in the battery, and partly from the use of too strong mercurial solution in preparing the surface, and was eventually overcome by lessening the number of cells, and dipping the previously cleaned articles in a *very weak* solution of mercury immediately before placing them in the plating liquid. If the deposit of silver is not firmly attached to the whole of the surface of the article, it is apt to rise in blisters and peel off when the articles are subjected to the after-process of burnishing. This non-adhesion

of the silver was particularly apt to occur with articles made of Britannia metal, and with this particular alloy it was not overcome for several years; it was then effected by first coating the articles with copper, by electro process, in a solution composed of sesquicyanide of copper dissolved in an aqueous solution of cyanide of potassium, a liquid invented by Mr. Wright for the purpose of coppering articles of iron previous to silvering them, and patented in September, 1841. The method now in use for coating Britannia metal is different; it consists in first forming a thin deposit of silver upon the article, by a powerful battery, in a solution containing but little cyanide of silver and much cyanide of potassium, thus transferring the article to the ordinary silver-plating liquid, and completing the deposit therein in the ordinary manner: this process was first employed by Mr. Thomas Fearn, from whom it was purchased by Messrs. Elkington for a considerable sum of money.

Another difficulty arose in a tendency of the deposited silver to assume a granular or semi-crystalline state upon the surface of the articles, especially at their edges, during the process of deposition; this was overcome by employing proper proportions of the ingredients in the plating solution, and carefully adapting the power of the battery to the size of the articles. In addition to these difficulties another was experienced; the articles after being plated and finished, in a few months became much discoloured: this was a consequence of too rapid deposition. And a still more serious difficulty, which required several years to surmont, arose from the opposition of the manufacturers of plated wares of Sheffield to the new method of plating; they objected to take licenses for the new process; but now the electric method is the only one they employ. A dispute also arose between Messrs. Elkington, of Birmingham, and Ruolz, of Paris, the latter having obtained a knowledge of the process and taken out a patent for France a short time before Messrs. Elkington, and a trial at law resulted, in which it was established that Messrs. Elkington were the original patentees of the cyanide of potassium solution, and it was finally settled by a compromise between Messrs. Ruolz and the patentees for the use of the process. In consequence of these and other difficulties, it was at least seven years before it became both practical and remunerative.

In electro-plating the deposited metal spreads as readily over the most elaborately engraved or figured surfaces as over the plainest forms, and in consequence of this property the new process caused a new and great extension of trade in plated articles to spring up, because articles of complicated forms, or with elaborate designs upon them, could not be made by the old method without very great expense. By the

new method they were first cast of the requisite shape in German silver, and then coated with the precious metals, whereas by the old plan they required to be made from flat sheets of copper previously plated with silver by fusion; the different parts of a complex figure were first stamped into the requisite forms separately, and then the various pieces soldered together to make the entire figure; and thus a figure which could be made entire in a single piece by the new mode, required to be formed of several or many pieces by the old one, and after a moderate amount of wear the lines where the parts were soldered together became visible, and greatly disfigured the object, and those lines could not again be covered with silver. By the old plan, every portion of a figure which was "undercut," *i.e.* in which the external parts overhung the internal ones, as the mouth or ear of an animal, for example, required to be made of several pieces, whilst by the new method such parts could be made entirely in one piece with the whole figure, and be coated with the precious metals all over, without any seam or joining. A great scope for the extension of beauty and taste in designs of metallic figures and vessels thus commenced, which has gradually extended itself to electro-plated articles of very moderate price, such as tea-pots, coffee-pots, cream-jugs, sugar-basins, &c., the base of which consists of Britannia metal; and the electro process has thus enabled persons of limited incomes to enjoy the use of articles of elegant design previously inaccessible even to the wealthy.

The next event of importance in the history of electro-plating consisted in the application of magneto-electricity instead of electricity from a voltaic-battery to depositing purposes. In August, 1842, J. S. Woolrich took out a patent for the use of a magneto-electric machine instead of a voltaic battery for electro-plating. This machine, which is in use at Mr. Fearn's electro-gilding works, Birmingham, and various other places, consists of a revolving wheel containing at its outer edge a number of short bars of soft iron, upon which are wound coils of insulated copper wires, giving to the bars the appearance of a series of reels; the wheel is surrounded by a set of powerful steel magnets, which are immovable, and fixed in a case, and have their ends, or poles, all pointing towards the wheel, so that as the wheel revolves, each of the reels of wire with its iron core, passes in succession between and very close to the poles of each magnet. As each of these coils approaches a magnet, a current of electricity is developed in one direction, and as it leaves the magnet a current is produced in the opposite direction, and similarly with the whole of the coils. All the corresponding ends of the coils are connected with the axle of the wheel, from which the positive electricity of all the

spirals is collected by a metal spring which presses upon the axle and conveys the current onwards to the depositing solution; and all the opposite ends of wire are connected with an apparatus on the axle called a communicator or break, and this apparatus collects all the negative electricity of those ends and transmits it to another spring which conveys it to the plating vat. And thus, by quick rotation of the wheel, a rapid succession of electric impulses are generated, which are employed for plating purposes in the same manner as the ordinary voltaic current. The above machine is a very convenient source of electricity where a cheap motive power is at command, and where the quantity of electricity required is not very great.

The surface of silver deposited from the ordinary cyanide of silver and potassium plating solution has a frosted or snow-white appearance, which in many cases has to be burnished and made bright by mechanical means. This, with articles of highly figured design, and also with the interior of certain articles that required to be made bright, was a great disadvantage, as the process of burnishing is tedious, and with the interiors of vessels also very awkward to perform. As with the difficulty in the early period of the electro-process in obtaining thick deposits of firm silver, a little circumstance was the cause of that difficulty being overcome, so was it with this obstacle, and it happened as follows:—In the process of copying figures for electro-typing by a mixture of wax and resin, the surface of the wax is covered with a film of phosphorus by means of a solution of phosphorus in bisulphide of carbon. It was observed by Mr. Millward, at Messrs. Elkington's establishment, that when these prepared wax moulds were put into the cyanide of silver-plating solution for the purpose of receiving a coating of silver, other articles, such as spoons, forks, &c., which were being plated in the same vat, and especially those nearest to the wax-moulds, acquired a coating, more or less perfect, of *bright* silver, which occurred sometimes in patches, and sometimes extended all over the articles, instead of the ordinary snow-white deposit. This circumstance attracted attention, and induced Mr. Millward to try the effect of adding bisulphide of carbon alone to the plating liquid. Considerable success soon resulted; but at this juncture the secret escaped, and in consequence thereof a patent was taken out, March, 1847, by Mr. Millward and a person of the name of Lyons, who had acquired a knowledge of the secret, for producing bright deposited silver by means of bisulphide of carbon. This process has been constantly employed ever since, and is now in extensive use, and with its aid the silver is rendered very bright and the amount of burnishing required very considerably reduced, but it has the disadvantage of making the deposited silver much harder. Bright copper had been observed

about two years before bright silver, and occurred whenever a large number of phosphorized wax moulds were put into a solution of sulphate of copper to receive an electro-deposit of copper. Other substances possess the quality of imparting brightness to deposited silver, but none in so satisfactory or eminent a degree as bisulphide of carbon: among these may be mentioned bicarbonates of the alkalies, and many organic compounds, and it is probable that the brightness depends upon a *gaseous* body being dissolved in the plating liquid.

No important improvement in the electro-deposition of silver has since been made; and the process at present in use may be briefly described as follows:—A certain quantity of pure or virgin silver in a granulated state is taken, allowing about one ounce for each gallon of plating-solution required (the actual proportions, however, in use by manufacturers vary from a quarter of an ounce to two or three ounces of silver per gallon), a warm mixture of four parts of pure and strong nitric acid and one part of water, contained in a capacious vessel of glass or stoneware, is placed in a warm situation, where the air-fumes may readily escape without injuring persons or furniture; and small quantities of the silver are added, from time to time, as fast as it dissolves, care being taken not to add it in too large quantities at a time—otherwise waste will ensue—until nearly all the silver is dissolved. It is advisable to employ a deficiency of the acid mixture in the first place, and to add more of it towards the end of the process, taking care not to add more than will dissolve all the silver, but rather to leave a little silver undissolved, even with the liquid quite hot; by this means, the presence of much free acid is avoided, and an after-loss of cyanide of potassium and escape of poisonous fumes of prussic acid prevented. Each ounce of silver requires nearly one and three-quarter ounces of strong nitric acid to dissolve it.

The solution of nitrate of silver obtained is now considerably diluted with *distilled* water in a capacious vessel of stoneware, and there is added to it, in portions at a time, with stirring, a solution of cyanide of potassium of moderate strength as long as a white precipitate or cloud, which is cyanide of silver, is produced; this precipitate is allowed to subside between each addition, and it is very particular that as the precipitate produced becomes less copious the cyanide of potassium solution should be added more sparingly and at longer intervals of time, and that on no account should that liquid be added after it fails to produce a precipitate. This point requires some care and experience, but may be known by the cyanide of potassium solution producing a *transparent* but slightly brown appearance where it passes into the white and cloudy liquid: this transparency is caused by its dissolving the suspended fine particles

of cyanide of silver; if by accident too much cyanide of potassium has been added, a cautious addition of dilute nitrate of silver solution (for which purpose a little should be reserved) in a similar manner, will bring it back to the neutral or proper point: the whole is then well stirred and allowed to subside until the supernatant liquid is quite clear. Each ounce of silver dissolved requires nearly half an ounce of cyanide of potassium of ordinary quality to precipitate it.

The supernatant liquid is then filtered through a calico bag, the sediment put into the bag, and the bag filled five or six times successively with spring water. A small quantity of hydrochloric acid is added to the filtered liquid to precipitate any dissolved silver (of which there is always more or less), in the form of chloride of silver: this is allowed to subside, the clear liquid is thrown away, and the sediment retained on account of its silver.

Now, the wet contents of the filter are transferred to a capacious vessel, and to it is added, with constant stirring, a strong solution of cyanide of potassium until it is all dissolved, a memorandum of how much cyanide of potassium is used being made, because the amount varies greatly in different cases and is dependent upon the quality of that substance. If the cyanide of potassium is of ordinary quality, each ounce of silver employed will require about two or two and a half ounces of cyanide of potassium to re-dissolve it; whatever the quantity required to re-dissolve the cyanide of silver may be, an equal additional amount should now be added to the mixture to constitute *free* cyanide, and sufficient water then added to dilute the solution to the proportion of one ounce of silver per gallon, or any other strength that may be desired: the solution now only requires to be filtered and it is ready for use.*

In coating articles with silver by means of this liquid a voltaic battery is employed: the battery varies in its arrangement in different establishments and in different cases, but always contains dilute sulphuric acid and plates or bars of zinc. The battery most commonly used consists of a sheet of copper and a plate of amalgamated zinc immersed in a mixture of oil of vitriol and water contained in a large stoneware jar; the zinc plate is connected by a copper wire with the articles to be coated, and the sheet of copper is connected by another copper wire with a sheet of pure silver, which is hung in the plating-solution near the articles. In this arrangement the electricity is generated by the action of the acid and water upon the surface of the zinc, and passes from the zinc through that

* This process is illustrated in Plate V. fig. 2. See also explanation at the conclusion of article.

Fig. 3.

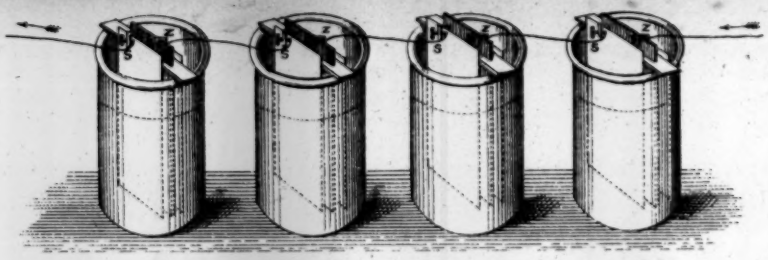


Fig. 1.

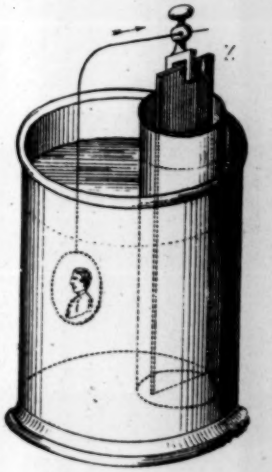
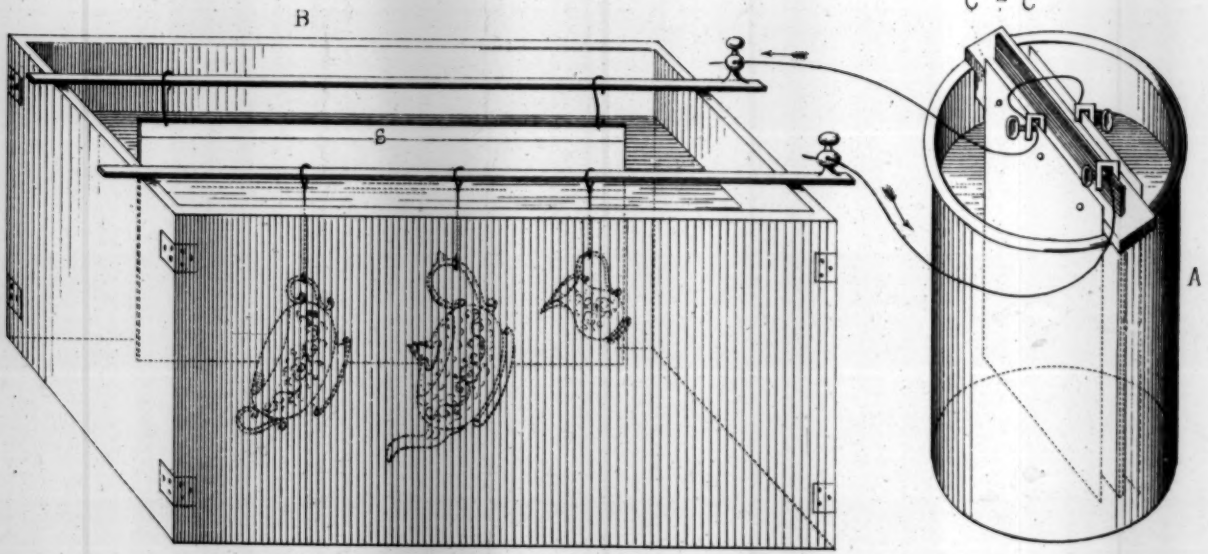


Fig. 2.



C. Gore del.

Electro plating apparatus.

W. West Lith.

Plate V.

liquid to the sheet of copper, then along the copper wire to the sheet of silver, then through the plating-liquid to the articles to be coated, and back to the zinc plate by the other copper wire.

The electricity in passing from the surface of the sheet of silver into the plating-liquid causes the cyanide of potassium to act upon that metal and dissolve it, and at the same time the electricity passing into the surface of the articles decomposes the solution in contact with them and causes it to yield up its silver to those surfaces; and these two simultaneous actions are perfectly equal in amount, *i. e.*, for every ounce of silver dissolved on one side an ounce of silver is deposited on the other, and thus the amount of silver in solution remains unaltered for an indefinitely long period. The only alteration that takes place in the liquid is that it becomes unequal in composition in different parts—that portion of it about the dissolving-plate becomes richer in silver and specifically heavier, and therefore sinks to the bottom of the vat, whilst that about the articles becomes poorer in silver, specifically lighter, and rises to the surface; and this inequality renders it necessary to stir the liquid occasionally, otherwise the quality of the metal deposited upon the articles would be different at the upper ends to what it is at their lower ones.

In most electro-plating establishments two or three such battery-cells as those described are used for depositing silver, and in the early period of plating a much larger number was used. When several cells are employed, the zinc plate of the first one is connected by a wire with the copper of the next, and so on throughout the series, leaving the extreme copper at one end and the extreme zinc of the other to be connected with the vat in the manner described: by this means there is a course opened throughout for the electricity to circulate, and each additional cell or pair of plates imparts an additional impulse to the electric current.*

Several other kinds of voltaic batteries besides the one described are also extensively used in electro-deposition; there is Smee's battery, which contains a sheet of platinized silver instead of the sheet of copper; Grove's, which consists of amalgamated zinc in dilute sulphuric acid and a sheet of platinum in strong nitric acid, the two liquids being kept from mixing freely, but allowed to touch each other by means of a separating diaphragm or cell of unglazed (*i. e.* porous) earthenware; and Bunsen's battery, which is similar to Grove's; graphite (obtained from gas retorts) being, however, employed instead of the sheet of platinum. Daniell's battery, which con-

* Plate V. fig. 3. Zinc and silver are here used.

sists of amalgamated zinc in dilute sulphuric acid, and copper in a solution of sulphate of copper, the two liquids being separated by a porous partition, is not much used for electro-plating; and the preference of one battery over another for electro-deposition depends partly upon the bias of the plater in favour of that particular battery, but chiefly upon the special purpose for which the battery is intended; in cases where great resistance is offered to the passage of the electric current, as in solutions for coating articles of iron, &c., with brass, the more powerful batteries of Grove and Bunsen are used. Whichever of these batteries is employed, and whatever may be the metal intended to be deposited, the article to receive the coating is always connected with the *zinc* plate of the battery, and the metal to be dissolved is connected with the copper, silver, carbon, or platinum, as the case may be.

All metallic articles that are to be coated with silver or other metals by electro-process require to be perfectly cleaned and prepared before being placed in the plating-liquid, otherwise the metal deposited upon them will not adhere properly. To clean them they are at first immersed in a boiling solution of caustic potash to remove greasy and tarry matters; then, if they are formed of German silver, brass, or copper, they are washed in water, dipped momentarily into aquafortis, again washed in water, then dipped into a very dilute solution either of nitrate of mercury or of cyanide of mercury and potassium, and immersed in the silver-plating vat. In cases where it is desired to know the quantity of silver deposited upon them, they are weighed after cleansing, and also at intervals during the process of deposition. Articles formed of Britannia metal, lead, tin, and similar metals or alloys, are not dipped into aquafortis, but immersed in a weak silver solution immediately from the caustic potash liquid, to receive a thin preparatory electro-coating, and then transferred to the ordinary silver vat. The thickness of silver deposited upon articles is frequently very minute, as may be judged from the fact that full-sized iron snuffers are sometimes wholly coated with silver for two-pence each pair, and other common articles at proportionate prices.

After receiving the coating of silver, much remains to be done to the articles before they assume a saleable condition, they have to be "scratched" by a bundle of revolving fine brass wires to remove asperities; burnished to make them bright; in some cases, they have to be "oxidized" in particular parts. This consists in wetting those parts with a solution of bichloride of platinum, which blackens those portions; and, in other cases, different parts, as, for instance, the interior of cream-jugs, sugar-basins, &c., have to be electro-gilded. And in cases where portions of the exterior have to be gilded, the remaining

surface is coated with copal-varnish, to prevent the gilding from taking place on those parts. And, finally, the articles are washed in clean water, and at once immersed in hot, dry sawdust, which absorbs the moisture and dries them quickly, before they have time to tarnish. The processes of preparing and finishing articles are, in nearly all cases, much more troublesome than that of plating itself.

These various points of information are only the *outlines* of the process of electro-plating, and for the details the reader is referred to the various published works on the subject.

The scientific perfection of electro-deposition consists in its definite mathematical character. Under carefully prepared conditions, all the chemical actions that occur in the battery and plating-vat stand in certain precise mathematical relations to each other; for every 32½ parts of zinc dissolved in each cell of the battery, there are 108 parts of silver dissolved and 108 parts deposited in the vat; or if it be a copper solution, 31¾ parts of copper, or an antimony solution, 40 parts of antimony; for every 32½ parts of zinc dissolved in the battery, there are 9 parts of water decomposed, and if it be a Smee's, or a common zinc and copper cell, there is 1 part of hydrogen set free at the negative silver or copper plate; and similarly with all the chemical actions taking place in the various battery-cells and depositing liquids. Each action in a given circuit stands in a certain mathematical relation to each and all the others, and this is known as the law of "definite electro-chemical action."

The artistic advantage of electro-deposition consists in the great facilities it affords for the exercise of taste and design, and for more accurately imitating the forms of nature, as in rocks, animals, fruits, trees, &c. And its domestic utility and household economy consist in the greater degree of cleanliness and beauty obtained at so moderate a cost.

As long as arts and manufactures are left to be directed and improved by simple experience, their progress is extremely slow; but directly scientific knowledge is successfully applied to them, they advance with astonishing speed. For years the manufacture of plated metal wares existed without making any material progress; but, on the application of science, its progress became surprising, and called the attention of all persons to the new process.

Thirty years ago electro-plating for commercial purposes was unknown; but as soon as Jacobi and Spencer made known the results of their electrical experiments upon metallic solutions, the manufacture of plated wares began to advance; and so rapid has been its progress, that, at the present time, thousands of persons are employed in it, and electro-plate productions are used in all parts of the world.

Thus it is that man, to some extent the servant, but hoping to become more the master of nature, is daily striving to acquire a greater knowledge of the workings of natural forces, and to apply those forces to human benefit; he first becomes the obedient disciple of nature, in order that he may ultimately become its director; and so great a degree of success has already resulted from this course, that we are justified in expecting that, at some future time, science will extend its helping hand to all trades and manufactures, and that ultimately scientific principles will be universally recognized as the great "regulators of productive industry."

EXPLANATION OF PLATE V.

Fig. 1 represents what is termed a "single-cell electrotype apparatus." It consists of an outer vessel of glass or stoneware nearly filled with the depositing solution of silver or copper, as the case may be; standing within it is a narrow, deep vessel of *unglazed* or porous earthenware, containing a plate of amalgamated zinc, and about three-fourths filled with dilute sulphuric acid. The article to be coated is connected by a clean copper wire and brass screw with the zinc plate, as shown in the engraving, and is immersed in the metallic solution.

Fig. 2 represents the actual apparatus for electro-plating, as at present employed. It consists of two parts, the battery A, and depositing trough or vat B; Z is the zinc plate, and C C the two copper plates of the battery, and S is the silver-dissolving plate in the metallic solution: the arrows represent the direction of the electric current.

Fig. 3 represents the mode of connecting several battery-cells in series when additional electric power is required: the battery-plates in this sketch are represented as being composed of zinc, Z, and silver, S, instead of zinc and copper; the zinc of the first cell being connected by a copper wire with the silver of the second; the zinc of the second with the silver of the third; and so on.

NOTES OF THE EXHIBITION.

No. II.

THE MINERALOGICAL DEPARTMENT.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

A COLLECTION of Minerals, carefully made, well arranged and selected, and placed with a view to their economic value, would, perhaps, be as interesting and attractive as any of those collections occupying the numerous halls and almost interminable corridors at South Kensington whose glittering treasures are soon about to fade and melt away from before us. Objects of large dimensions, of wonderful beauty of form and colour, of vast cost, and of enormous intrinsic value—objects representing great sources of national wealth—objects noble in their massive proportions, and interesting in proportion to the difficulty experienced in obtaining and removing them—collections speaking for themselves as showing series of manufactures and processes; all these certainly admit of being placed in such a way as to astonish, amuse, and instruct.

That such might be the result of a great series, illustrating the mineral wealth of the world, seems beyond a doubt; but that any such result has been attained at our great International Exhibition no one will venture to assert. There is ample material, whose effect is lost for want of right associations. There are separate objects in abundance, capable of attracting and really attracting crowds; there is gold exhibited in a profusion and barbaric splendour worthy of the earliest period of human history. Never, perhaps, in the world's history was such raw material of representative wealth brought together and exposed to public view. There are copper ores also—slices of veins adapted to make the mouths of mine speculators water. There are building stones and marbles, coals and china clay, and manufactured results in abundance. At a distance from these are plans, models, and illustrations of the mode of rendering them useful. But few ideas can be obtained by the

uninitiated. There is no sequence. All is disorder and confusion; little assisted by any of the published descriptions—not at all assisted by arrangement within the building.

After a general review of all the objects in the Exhibition belonging strictly to the department of mines and quarries, minerals, metals, and mineral manufactures; and after carefully considering what is meant by progress in such subjects and what is deserving of reward in such a department, we think it may be both useful and interesting to the readers of the "POPULAR SCIENCE REVIEW" to know the conclusions arrived at by an independent observer somewhat accustomed to examine and compare such matters. Whatever opinions may be expressed, the facts on which they are founded will, at any rate, be stated, and the student who has also examined the collections, may compare his impressions with the opinions here given, while those who have not been so fortunate as to see for themselves will be better off by reading this connected outline than by any study of the disjointed catalogues.

The great value, if not the only use, of collections such as have been placed in the International Exhibition must be to show, for the purposes of comparison, the sources of material wealth provided by Nature in various countries or districts. And this wealth must be shown, in order that, where it exists and has been hitherto neglected, it may be made available; and where, in two districts, it has been treated differently, the methods may be compared, and the best adopted for the future. It is desirable also that where new contrivances have been introduced, they should be made known to those concerned; and, generally, that the peculiar conditions of minerals and the varieties of wealth of different districts should be prominently presented for investigation. When, in the course of years, new discoveries of material or new applications of old material have been made, these, of course, mark progress. When new contrivances of working or manipulation have been invented, these should be clearly reported; and they also mark progress. When, as in raw material, there is no novelty, and the case hardly admits of anything of the kind, the raw material from different districts may still be so placed as to allow of better comparison. When a raw material is important, not for itself but for some manufactured material of which it is the foundation, then should the raw and manufactured materials be placed side by side.

Bearing in mind these principles, let us conduct the reader to the Exhibition, not confining ourselves to Class I., but extending our investigation to those other departments that include the same kind of objects; of these Class X. *a*, may be considered the most important.

The objects group themselves naturally enough under several heads, viz.:—Mineral Surveying, Mining Operations, Mineral Products, and Manufactured Minerals. Let us endeavour to follow each through the Exhibition, both of English and foreign articles. The task is not, perhaps, easy, but, for any useful purpose, we believe it is the only one.

1. *Mineral Surveying and Mining Operations.*—The long array of geological maps, commencing with those of the British islands, and including most of the countries in which mining operations of any kind are carried on, is one of the most important marks of progress in the Exhibition. In no department is the progress of scientific research more clearly indicated, and in none is it so manifest that the march of improvement in mining is no longer checked by those who adhere to the old Cornish maxim: "Where it is, there it is." Could one feel satisfied that the vast amount of work indicated on the geological maps exhibited is all sound and conscientious, the advance would, indeed, be little short of miraculous to those who remember the exhibition of such maps and accompanying sections in 1851. Unfortunately, these maps are, many of them, only first approximations; and it will require more labour to correct and set them right than has been taken to construct them. In this matter, however, it is certainly true that positive error is the first step on the road to truth. Where there is nothing to find fault with, no advance is made; but it is easy for any one using an imperfect map to correct it.

Among the foreign maps, the Austrian are the most extensive and showy, and some of the Prussian probably the best. The increase in the coloured portion of the maps of the Ordnance Survey of the British Islands since 1851 is not large in appearance, but the advance is real, and for the most part trustworthy.

The mining plans exhibited, and the various models of mining operations, do not offer anything remarkable either in novelty of method or illustration. Certainly, they offer no proof of progress; and in this respect there has probably been little done within the last eleven years that had not been as well done previously. It is but a very short time since one of the most distressing accidents on record occurred in a coal mine, from a neglect of the very first principles of economic mining—that of having more than one access kept up to every part of a mine except the newest and most advanced headings. There is nothing in any of the plans exhibited that shows any practical advance on the old methods of winning coal or getting ores.

Although, however, there is not much new matter, there are some admirable photographs of mining and quarrying operations, especially the latter—so good as to deserve the

most careful attention. Perhaps the photographs are the most instructive, as they are certainly the most pleasing and most easily understood of all the mining and quarrying illustrations.

Of mining models there are several, very well constructed, and one that ought to have been exceedingly popular. A large gold crushing and washing machine, in the great court of the Eastern Annexe, was long unable to do itself justice, and the interest that would have attached to it was thrown away on a hand illustration with a tin basin. Important as the subject of gold-mining is, there are few noteworthy modifications of ore-dressing especially adapted to gold sands, if we except some very weak repetitions of old German machinery introduced as novelties. An ingenious model of the method used in some of the Hungarian mines is exhibited. There are some ingenious contrivances to prevent accident on the breaking of the chain or lifting-gear in shafts.

2. *Mineral Products.*—It may well be supposed that the great strength of the exhibition of minerals would lie in this direction, and it certainly does so. Very irregularly exemplified—some departments sadly weak, some ridiculously prominent—some difficult to see, and more difficult to judge of; still there is within the walls of the building an amount of material which, if it had been fairly presented, would have possessed the most absorbing interest.

Let the reader figure to himself the result had there been in the Exhibition a Court of the Precious Metals. Had all the gold exhibits been collected into one space, the mere area occupied would have helped to impress the visitor. The gilt pyramid, ridiculous in the place which it filled, would have assumed an importance and a meaning in the centre of such a court; and the various collections grouped around would have told with wonderful effect their important tale. The whole history of gold, its real properties, and its sources of value as a representative metal, would have been at once felt and understood. Never was there a better opportunity, and never was an opportunity so lost and frittered away.

In spite, however, of everything, the collections of gold, especially from Victoria, are of the most singular interest. The grains and the pepites, the small and the large nuggets, the crystals and the flat discs—all are present in abundance and variety—all are good and true. The largest nuggets are well represented in useful models, so as to give completeness to the exhibit. Besides the Victorian gold, there is much from other parts of Australia. California is not represented, but Vancouver's Island has sent an interesting series. A remarkable and interesting group of specimens is sent from the

recently discovered localities in North Wales, and there are some specimens, not without interest, from the Brazils.

Near the gold is placed the metal platinum, in lumps of a magnitude never before produced, surrounded with the still rarer metals—iridium, osmium, rhodium, palladium, and ruthenium. In this case, the manufactured platinum is exhibited by Messrs. Johnson and Mathey, side by side with the metal. The French manufacturers of the same metal have placed some fine chemical utensils in their court since the opening of the Exhibition. These were, no doubt, intended to outshine the productions of Messrs. Johnson and Mathey. They are extremely beautiful, but inferior in variety, and not superior in execution.

As an exhibition of progress, then, the precious metals, with the exception of silver (which, although there are some fine snags from Norway, is little exemplified either in ore or metal), must be considered as justifying every expectation. All that is remarkable is new, and has never been put together as a group before. All that was wanted was that the articles should have been so placed as to illustrate each other.

Another interesting group might have been made by bringing together a number of miscellaneous and mixed metals and metalliferous minerals. A beautiful series of manufactures of aluminium—a metal that will some day enter largely into use—was itself a great illustration of progress, though a final result is not yet attained. The manufactures of German silver are well illustrated, but the illustrations as usual are quite unavailable for comparison. Ores of mercury are shown from various localities. Ores of chrome, antimony ores, and other miscellaneous but valuable minerals, may be found huddled into corners unnamed and neglected amongst the multitude of more showy, but less really interesting objects around.

Copper is one of the most important and valuable of the common metals. Some of its ores exhibited are very remarkable, but are accompanied with no general account, and can hardly be said to be instructive. From Australia, the series is extremely large, and includes many specimens of great interest. From Canada, also, there is a fine series. Native copper—the rich carbonates, both green and blue, and the more common sulphurets, are all present. Had they been placed so as to be capable of direct comparison with those from other ore-producing districts, and had the various important details of the veins been duly recorded, this part of the Exhibition might have possessed considerable value. As it is, few, probably, will look twice at the long series of dust-covered minerals dotted at intervals over all parts of the building—on tables in and

near the Eastern Annexe, on the floor in Greece and Sweden, piled in a corner in France and Belgium, and only arranged in the Zollverein and Austria. Spain and South Africa, the Brazils and Portugal, and many other countries, exhibit specimens for the most part utterly unrecognizable.

To lead and zinc ores, the remarks already made with regard to copper apply in a general way. The varieties exhibited are, however, fewer and less important. There is nothing remarkable suggested as to either the ores, or the treatment of the ores, of any of these metals, or of tin.

Iron comes next in order. There is in the Exhibition no general collection of ores, and, on the whole, the modern sources of supply in England and Europe are somewhat imperfectly indicated. Still, with some search, and by wandering to some distance, a valuable series may be made out. The metal itself is largely and well exhibited. Progress might easily have been shown in this matter by a reference to the vast additions to the resources of ore, since 1851. Progress is shown in the increased magnitude of the smelting furnaces. Models of furnaces are exhibited the yield of which is said to reach, in the case of Messrs. Schneiders' works, more than a hundred and twenty tons in the twenty-four hours. For these large yields the rich hæmatites are employed. Considering the valuable series of iron ores in the Exhibition of 1851, it is much to be regretted that the Museum of Economic Geology did not take the opportunity to complete the series by a systematic arrangement of ores from the new sources.

England, of course, is not alone in the exhibition of iron; Belgium, Austria, Prussia, Sweden, and many other countries have exhibited all the varieties, and generally in a very favourable state. There is much advance observable in the manufacture of the metal, and in the magnitude of the pieces that can be cast, forged, and turned.

But the metals form only a part of the vast series of mineral products. If the precious metals deserve a court, and would have justified great exertion to bring together the various specimens for comparison, the most precious of all minerals, *carbon*, would have well filled another and a prominent place. Certainly, in the exhibition of minerals, carbon should have been placed first, if money value is regarded; and if variety of condition is interesting, no substance in nature can compare with it. As it is, there are scarcely two important exhibits of coal near each other.

Leaving the diamond to take its place among manufactured jewels for personal decoration, there yet remain coal and graphite among carbon minerals. The former is exhibited very imperfectly; the latter very perfectly, thanks to the recent

discovery of M. Alibert. Of coal there are no very fine specimens, such as graced the Exhibition of 1851, the only representative of them being an ugly pile of square blocks of poor mineral from Nova Scotia, badly put together, and utterly unillustrative, rather resembling a large walking-stick than a coal seam, but—by the geologists on the jury—rewarded with a medal as "one of the thickest known seams in the world." As there are known seams of forty, sixty, and even a hundred and fifty feet in thickness, this medal at least seems undeserved.

The coals, like the ores, are distributed over the whole building, and, for the most part, soon became in such a state that no judgment could be formed as to their merits. Of the whole number, the Austrian are perhaps the most complete, but they are badly placed, at the bottoms of wooden boxes, and almost out of sight. The Zollverein specimens are well arranged, well selected, and instructive; the Belgian are large, and also well selected; but from other countries the varieties are rarely sufficiently marked to justify an opinion. One thing, however, is very clear and very satisfactory. Almost every country in Europe, and many countries elsewhere, possess coal, and are aware of the fact. There is more progress in this matter than might, at first, be supposed, and the progress is steady. It might have been made very clear. There are some fair examples of coke.

While coal has long been steadily advancing in use, and is constantly better known and more worked, another form of carbon—graphite, or plumbago—has very long remained stationary. For many years there has been actually no yield whatever of the best kinds of this mineral in the old locality, and no new deposit has been heard of. Suddenly the Exhibition brings us acquainted with M. Alibert, a Frenchman, who has found, far away in the wildest parts of Siberia, a mass of graphite so large and important that its discoverer makes royal presents of it in the most liberal manner, and seems ready to supply the European market into the bargain. Russia, on this occasion, has again astonished the world. In 1851, the enormous and costly display of veneered malachite made it impossible for other exhibitors of that beautiful stone to be attended to. In 1862, the plumbago trophy carries off the palm, and is equally unapproachable.

To those who have not seen this curious exhibition it is almost impossible to give an idea of the effect. Cut and broken into every shape; rough and polished, and of many sizes—surely so much black lead was never prepared for view before, and, probably, never will be again. It is said to be equal in quality to the best from Borrodale, and is already largely manufactured into pencils by the celebrated German manufacturer,

M. Faber. The value of the black lead exhibited must very much exceed a thousand pounds sterling.

With some of M. Alibert's plumbago, and also serving as the footing for a group of stuffed animals, are exhibited the largest specimens ever seen of that singularly hard and rare mineral, nephrite, or jade. The principal stone weighs upwards of half a ton. As well might we expect to see a diamond weighing a pound as a precious stone of this magnitude; but there it is before us in the nave of the building, not staring one in the face, but modestly retiring, and probably not noticed by one out of ten thousand persons who think they have seen all the remarkable things, and who actually have looked at the stuffed animals that partly conceal this treasure. As it lies in the case uncut, the value is estimated at about £1,600 sterling. Other wonderful specimens of polished *pietra dura* are adjacent, cut into vases and columns, little remarkable for their form, but of the most extreme hardness. These articles are among the most characteristic of the Russian and Swedish manufactures in stone.

3. *Manufactured Minerals.*—Of other stones, valuable for their great beauty, and worked into decorative shapes, there are many specimens. The rich dark green and red serpentines of the Lizard, in Cornwall, are the most striking and numerous articles of this kind exhibited. Some are very good, but in many of them an absence of good taste must be remarked, for an attempt has been made to use them for purposes for which they are not adapted. Very beautiful in places, these stones abound in flaws and weak white parts. Thus a large flat surface is generally a failure, while smaller and worked surfaces conceal or avoid the flaw.* Except the black marble of Derbyshire, there is no more beautiful or costly marble in the British islands, and few finer in Europe, than this serpentine; and, although there are many objects constructed of it in bad taste, there is a decided improvement in taste and style of manufacture when comparison is made with 1851.

With much that is beautiful in marble manufacture, there is much that is weak, and much that is positively bad, nor is the bad taste confined to our own countrymen. In all these matters progress is desirable, and nothing can promote it more than the means of comparison afforded by a grand exhibition open to the whole world. With the good taste in style generally observable in Italian works of art, there is an adaptation of material to its object which cannot be too carefully

* This variety of serpentine requires to be treated almost like agates for cameos. The places and colours of the flaws should be studied and converted into beauties.

studied. Thus the forms adapted for marble fail in granite. The granite manufactures, chiefly from Aberdeen and Cornwall, are beautiful in quality, but small in number and variety.

Of constructive materials, slates are the most remarkable. The exhibition of them in 1862 is far superior to that in 1851. Probably no such collection as that now made was ever brought together, and certainly none could be obtained out of England. These objects are not perhaps attractive; but they astonish by their size, and by the perfection of the cleavage, admitting the preparation of long, hard, firm slates, a sixteenth of an inch only in thickness, and of slabs, without a single flaw, two hundred square feet in area. The continental slates are very poor compared with these.

One word here with regard to the imitative marbles, enamelled on slate, by Mr. Magnus. It is impossible to praise too highly the progress made by this manufacturer since 1851. He has attained so near to perfection, that it is difficult to imagine what will be his next improvement. These imitations seem especially adapted for house decoration, owing to their extreme hardness and moderate cost.

We have little space left to notice the remaining objects exhibited in this large and important class. China and pottery clays, fire-clays, and sands, do not change, and show no progress. Mica and steatite, and some other minerals exhibited, are equally stationary. There are a few educational collections in the building, but these also offer little worthy of notice; and the same remark may be made concerning the cements and artificial stones.

One word of comparative remark in regard to the different countries. Except Australia, no country has shown a great stride in advance of the last Exhibition in its mineral produce. England, Wales, and Scotland, have sent less, and what is sent is on the whole of smaller interest, than before. Ireland has hardly sent anything. France has done little, and not better than before. Belgium has done well, and the Zollverein admirably. Austria, on the whole, is good, but justice has hardly been done to its collections. Canada, and the other British provinces of North America, are respectable, and even good. Spain is slovenly, and Portugal little better. Russia decidedly good. Sweden, Norway, and Denmark, not remarkable. Brazil is good.

Thus, in a few words, we have endeavoured to sum up the impression made by a study of the minerals of the Great Exhibition of 1862. We doubt exceedingly whether another such exhibition, conducted in the same manner, would be in any sense desirable at the end of another decennial period; for the means of instituting a comparison are so very few, and

the effort to compare so fatiguing, that probably very few persons have made the attempt. That the juries themselves did not examine too closely seems likely, from the profusion of medals, and "honourable mentions," distributed without much judgment, and often entirely without or against reason.

While, however, we believe, that in the state presented to the public, the Exhibition in this department is not what it ought to have been, we are satisfied that an orderly grouping of similar objects from different countries, for the purposes of comparison, would be productive of great good. It is not easy to say how far this is practicable generally. It may not be desirable in manufactures, which of themselves are definite objects of interest. But in the case of raw material, there seems little reason to doubt that order might be attained, and no doubt whatever that it is in every sense desirable and absolutely essential to ensure a proper use being made of the opportunity offered.

No. III.

CHEMICAL PRODUCTS.—THE APPLICATION OF WASTE.

BY WILLIAM CROOKES, F.C.S., EDITOR OF THE "CHEMICAL NEWS."

THE progress of our great chemical manufactures during the last ten years, as exemplified in the International Exhibition of 1862, appears chiefly to have been directed towards the utilisation of waste substances. The casual visitor to the Exhibition, wandering through the Eastern Annexe, and noticing the grand scale and great importance of some of the manufactures there illustrated; the gorgeous colouring matters exhibited by Messrs. Perkin and Son; and Simpson, Maule, and Nicholson; the stupendous blocks of alum; the beautiful yellow and red crystalline masses of ferro- and ferri-cyanide of potassium; the enormous cakes of paraffin, a chemical curiosity in 1851, one of the largest chemical manufactures in the world in 1862; and, knowing the incalculable boons which science has bestowed upon our national wealth and the world's civilisation by the introduction of the lucifer match, and development of the phosphorus manufacture, artificial manure, paper, &c.,—the visitor would be little prepared to hear that most, if not all, these im-

portant commercial products are manufactured from materials formerly thrown away, and at first sight apparently valueless and repulsive.

Dirt has been aptly defined as being valuable matter in the wrong place, and it is a striking characteristic of the chemistry of the present day that it converts substances, apparently the most worthless, into commercial utilities, and even fashionable luxuries. The manufactures alluded to above, and those of Prussian blue, disinfectants, glue, &c., are striking illustrations of this chemical utilization of waste materials, and we shall endeavour, in the following remarks, to show how they have all sprung into existence by the application of chemical facts and principles to such waste materials as gas-water, coal-tar, rags, and bones.

When coal is distilled in close vessels for the purposes of the gas manufacturer, various other products are obtained at the same time. A large quantity of offensively-smelling water comes over; the various sulphur compounds present in the coal yield up this element to the gaseous products, whilst a considerable bulk of tarry matter is also produced. Now the object of the manufacturer being to produce as much gas as possible in a practically pure state, all these accessory products were for many years looked upon as necessary evils, to be got rid of as quickly as possible. The gas-water and tar were thrown away into the nearest stream, where they killed the fish and poisoned the atmosphere for miles around, whilst the sulphur was removed, or at least supposed to be removed from the gas by means of lime, or, as more recently adopted, through a mixture of sawdust and oxide of iron, about which more will be said anon.

The first of these noxious products, the gas-water, has been utilized in the following manner. It owes its bad smell principally to the presence of ammonia and sulphur compounds, and it is only necessary to add some quicklime to this, for it to seize upon the acids with which the ammonia is in combination and liberate the alkali. This gas is conducted into chambers where it meets with carbonic acid, forming, after appropriate purification, the salt known in commerce as carbonate of ammonia, about 2,000 tons of which are made annually from this liquid. If, instead of distilling the gas-liquor with lime, a strong acid is added to it, hydrochloric for instance, itself a waste product, the compound known as sal-ammoniac is produced, which is of very great value in the arts, being the principal source of the more common salts of ammonia met with in commerce; the *liquor ammoniæ* of pharmacy, or hartshorn, being made by distilling this purified sal-ammoniac with lime, and conducting the evolved gas into water. The uses of this

ammonia are well known; not only is it largely employed in medicine, but, when mixed with some aromatic substance, it is used in scent-bottles, thus affording a striking instance of the transmutations effected by scientific agency, the fœtid liquid of the gas-works being transformed into a scent used by ladies as a cherished luxury. Besides sal-ammoniac, the manufacture of which from gas-water exceeds 4,000 tons annually, about 5,000 tons of sulphate of ammonia are also produced by adding sulphuric acid to the gas liquor. This is of great value as a manure, and is also one of the principal component parts of alum, so largely used in dyeing and calico printing.

This compound alum consists of the earth alumina in combination with ammonia and sulphuric acid. Chemically speaking it is a double salt of sulphate of alumina and sulphate of ammonia, and is prepared among other ways by acting upon a mineral containing alumina with sulphuric acid, and then mixing the resulting liquid with sulphate of ammonia. For the purposes to which alum is applied the sulphate of ammonia is superfluous, as all that the dyer wants is a solution containing the earth alumina; but it must have no impurities in it. Now the only practicable way of purifying a salt is by crystallization, and it so happens that alumina salts are about the most uncrystallizable in the whole range of chemistry. Fortunately, however, the double salts which alumina forms with alkalies possess, like most double salts, very strong crystalline tendencies, and therefore manufacturers add sulphate of ammonia to the sulphate of alumina in order to obtain a compound which is capable of ready purification owing to its eminently crystallizable properties.

But the alum manufacturer is not only indebted to gas makers' by-products for his ammonia, but likewise for the sulphuric acid. We mentioned that one of the chief impurities in gas was sulphur, and alluded to a method of removing this body by a mixture of sawdust and iron. The action of the sulphur compound upon this is to produce water and sulphide of iron; when it has in this manner absorbed as much sulphur as it can, air is passed through the mixture; the effect of this is to convert the sulphide of iron back again into oxide of iron, the sulphur being separated in the form of powder. The mixture being in this way revivified is ready to absorb a fresh quantity of sulphur-impurity from the gas, and thus the processes go on alternately until the pores of the mixture are completely choked up with the deposited sulphur.

This spent material is now used for the manufacture of sulphuric acid by burning it in properly constructed furnaces, and allowing the products of combustion to mix with nitrous vapours and aqueous vapour in enormous leaden chambers. The sulphur

is caused to combine with the greatest possible amount of oxygen, becoming converted into sulphuric acid, or oil of vitriol as it is generally termed when in a concentrated form. Sulphuric acid, which is also made from other sources of sulphur, is one of the most important chemical manufactures of the country, and upon it depends the equally important manufacture of soda from sea salt. An eminent philosopher* of our times has expressed the opinion that the commercial prosperity of a country may be estimated by the amount of sulphuric acid which it produces, and that the consumption of soda affords a fair criterion of a nation's civilization, inasmuch as soap and glass, the manufacture of which depends upon these former, are inseparably connected with our ideas of cleanliness and comfort. Respecting the *soap-test*, there may be some reasons to question its accuracy, but the production of sulphuric acid lies at the root of nearly every industrial art or manufacture in which chemical agencies are employed, and may thus be looked upon as a fair test of the intellectual activity of a nation.

We now pass on to the oily matter which is obtained in the distillation of coal. This is a very complex body, containing a large number of substances of different degrees of volatility, and varying greatly in their characteristics. Some are alkaline, as, for example, the now well known substance aniline, others are acid, but by far the greater portion are neutral. By appropriate chemical and mechanical means these components of the crude coal tar are each obtained in a state of purity. The lighter portions, known by the name of coal naphtha, consist in great measure of benzol, a liquid which has been for several years past applied to a considerable number of uses in the arts. For the present we will confine ourselves to the part which it plays in the production of the brilliant colouring matters, the manufacture of which is so well illustrated in the Eastern Annexe of the International Exhibition. When benzol is acted upon with strong nitric acid it becomes converted into a heavy oily liquid, of a yellowish colour, which has an intensely sweet taste, and an odour powerfully recalling that of oil of bitter almonds. This is called nitro-benzol. It is employed to some extent in perfumery and in scenting soap, as well as in confectionary, where, owing to its non-poisonous properties, it forms a good substitute for the highly poisonous oil of bitter almonds. But the chief interest which attaches to this substance is on account of the transformation which it undergoes under the influence of certain chemical reducing agents. To follow these different changes step by step would require us to devote some little space to chemical explanations and formulæ, but a general idea

* Baron Liebig: *Familiar Letters on Chemistry.*

of the transformations may be given without taking up much space. Benzol consists of the elements carbon and hydrogen in the proportion of twelve of the former to six of the latter. The action of the nitric acid upon this is to remove one of the hydrogen atoms and put in its place an atom of peroxide of nitrogen. When this nitro-benzol is acted upon by certain chemical agents of the class called reducing (as for instance a mixture of iron-filings and acetic acid which is now generally used), the whole of the oxygen which the peroxide of nitrogen has brought into the nitro-benzol is removed, and two parts of hydrogen are added, so that the original benzol becomes transformed into a body containing twelve parts of carbon, seven parts of hydrogen, and one part of nitrogen. This is aniline, a substance which illustrates in a striking manner the effect that demand exerts upon supply. Some years ago all the laboratories in Europe did not contain a pound weight of it, whereas it is now manufactured by thousands of gallons at a time. There is still another stage to be passed before we get to the colouring matter, but here the change is by no means well understood, and the best processes are kept scrupulously secret. The action is, however, the reverse of the one just now described, being the addition instead of subtraction of oxygen, and it is by the employment of different oxidising agents that we get mauve, magenta, roseine, azuline, bleu de Paris, and other gorgeous dyes which have received arbitrary names. Mauve or aniline purple was first discovered by Mr. Perkin, and in his case at the Exhibition may be seen a very complete and beautiful collection showing the different stages of the manufacture, from the crude coal oil up to a gigantic block of the pure dye itself upwards of a cubic foot in bulk, and for the production of which the distilled products from 2,000 tons of coal were consumed. The tinctorial properties of this dye are very strong. Mr. Perkin illustrates this by exhibiting a gallon jar filled with a beautiful violet solution, the colour of which is communicated to the water by one grain only of the dye. To render this illustration more striking there is placed near it a similar sized jar filled with crude coal-tar, the whole of which would have to be employed to produce this single grain of colouring matter.

The gigantic scale upon which the manufacture of these colouring matters is carried on and the perfection to which it is brought are strikingly illustrated by Messrs. Simpson, Maule, and Nicholson. This firm have succeeded in producing the beautiful colour known as magenta in a crystalline form, and one of the most striking objects in the whole department is the magnificent crown of acetate of rosaniline (the chemical name for magenta), which occupies so prominent a position in their

case. One of the most curious points about this is the colour which it exhibits. The rich, deep, rose tint which the body communicates to silk, &c., instead of being concentrated and intensified until deepened almost to a black, here shines and glistens from the facets of the beautiful crystals with a rich metallic green lustre, sparkling in the sunshine like the plumage of tropical birds, or the wing cases of certain beetles. Crystals such as these are unattainable except when working on a manufacturing scale. Laboratory experimentalists had already ascertained the fact that magenta was capable of assuming a regular form; but crystals such as compose this crown—the planes in some being nearly an inch across—can only be developed by manufacturers whose crystallizing vats hold upwards of £2,000 worth of colouring matter.

Before leaving this subject, we may draw attention to the important branch of national industry which this manufacture is assuming, and pay our tribute of admiration to the skill and intelligence of the chemist who has succeeded in converting the most nauseous and repulsive by-products of gas manufacture into such lovely colouring agents. Through his exertions, England will cease to import colouring matters, and will become a dye-exporting country.

Another product of the distillation of coal now claims our attention. In 1841, Liebig said that it would certainly be one of the greatest discoveries of the age if any one should succeed in condensing coal-gas into a white, dry, odourless substance, portable, and capable of being placed upon a candlestick or burned in a lamp. Ten years afterwards, Mr. Young showed, in the Great Exhibition of 1851, a single candle made from paraffin, a waxy-looking solid, which was known to be obtained in small quantities from the distillation of peat, wood, or coal. Liebig's prediction was here fulfilled. Paraffin is absolutely identical in composition with the most luminiferous portion of coal-gas, and only differs from it in being in a more condensed state; its per-centage composition of carbon and hydrogen is, in fact, identical with that of olefiant gas. Another ten years, and the commercial manufacture of paraffin has assumed gigantic proportions, and Mr. Young's establishment for its production, at Bathgate, ranks among the largest chemical works in the world. The composition of paraffin, indeed, renders it pre-eminently adapted for the production of light. It is a beautiful wax, melting at about 130°, and when heated to a considerably higher temperature (as when burning in the wick of a candle) it decomposes into true olefiant gas, producing a beautiful white light. A paraffin candle amounts, therefore, to a perfectly-constructed and portable gas works; its flame is not like that of an ordinary candle, but is identical with that of the

most perfect coal-gas, which is, indeed, self-produced as it is wanted, without any costly or complicated apparatus, and in a state of purity unattainable by ordinary means.

Intermediate between olefiant gas and the solid paraffin in condensation, but of the same per-centage composition, are a variety of other bodies which assume the form of oils more or less volatile in proportion to the number of atoms which are compressed into the same bulk. They are known by the name of paraffin oils, and their inflammability, volatility, and consequent danger, when used as household illuminants, increase as they approach in rarity the gaseous extremity of the scale, and diminish as they draw near the density of the solid. True paraffin oils must be carefully distinguished from spurious bodies of the same name ;* these contain various volatile bodies, the vapours of which take fire at the ordinary temperature, and which are as dangerous as common turpentine or benzol on the approach of a light. True paraffin oil will only burn in the presence of a wick, and is, therefore, perfectly safe. When burning, it also splits up into olefiant gas, and, therefore, produces a brilliantly-white light.

We stated at the commencement of this article that some of the products of the distillation of coal were acid bodies. The most important of these is carbolic acid, which is one of the principal constituents of creosote. This has recently been employed for sanitary purposes. Its antiseptic properties are remarkable, and when united with lime, it forms one of the most powerful disinfectants known. Carbolic acid is now prepared in enormous quantities from coal-tar, and has been applied with eminent success in several towns to the disinfection of sewage. It acts, not by destroying putrefactive principles as chlorine does, but it completely arrests decomposition. Animal matter washed over with a solution of this acid may be exposed for any length of time to the atmosphere without putrefying; and Dr. Lyon Playfair mentions an instance in which a human body was preserved for two months in this way until it reached a distant grave.

When carbolic acid is acted upon by nitric acid a somewhat similar effect is produced as with benzol under these circumstances; part of the hydrogen is replaced by peroxide of nitrogen, and a body known as carbazotic acid is produced. Within the last few years this body has been extensively employed as a dye. The colour which it communicates to silk or wool is of

* Nor must they be confounded with petroleum oil, which is now being imported largely from Canada and Pennsylvania. This substance will cause a great revolution in our modes of illumination, especially amongst the poor. It will be treated in a special article.—Ed.

a rich straw yellow. It is applied to fabrics with great readiness, requiring no mordant, and is one of the most permanent colours known. Carbazotic acid has other valuable properties; for instance, it is a valuable medicinal agent, being similar in its action to quinine, only when administered it exerts its tinctorial properties at the expense of the patient's skin, dyeing him a lively yellow. It also has an intensely bitter taste, and for these reasons it has been suggested that arsenic and other poisons should be mixed with carbazotic acid. In cases of slow poisoning, the yellow appearance of the person to whom it was administered would at once give rise to a suspicion of something wrong.

It is a curious fact, that from coal-tar may be extracted the three primary colours, red, blue, and yellow, and these being obtained, every other tint is easily produced by their admixture.

Our space forbids us even to refer to the other modes in which the former by-waste products in the manufacture of gas are utilized. We must now proceed to the next division of our subject—RAGS. We have spoken above of Baron Liebig's proposition to measure the civilisation of a country by the amount of soap which it consumes. We think a better standard of a nation's progress would be the value which it attaches to rags, for, as Dr. Lyon Playfair observes, it is quite true that as nations rise high in the world they appreciate the value of rags more, and are willing to pay a higher price for them from other countries where their value is not appreciated. First and foremost of the many applications of this humble material is the manufacture of paper; for this purpose we buy from other nations no less than 15,000 tons of rags annually, besides using up four times that amount derived from the waste of our own population, representing a money value of rags equal to £700,000. Within the last ten years, paper has been manufactured from numerous other materials, but nothing has yet been found out which can in any way compete with rags in strength of texture or beauty of quality. The manufacture of paper scarcely comes within the limits of the present article, but we may refer to a very valuable improvement which has been effected within the last few years in connection with this product. Mr. Gaine described a process by which ordinary unsized paper could be converted into a material similar to parchment, by a momentary immersion in sulphuric acid of a certain strength, and more recently Messrs. De la Rue and Co. have taken up the manufacture of this parchment-paper commercially. The transformation effected is very striking. A sheet of common white blotting paper, which will scarcely bear its own weight when wetted, is converted in a few seconds into a substance possessing all the pro-

perties of ordinary animal parchment, and so strong that it is only torn with great difficulty. The change is more remarkable inasmuch as no chemical alteration has taken place; the acid simply produces a molecular change, and is entirely washed away from it as soon as the desired effect is produced. The applications of this novel material are very numerous; its great strength (nearly double that of parchment), and its indestructibility by water or moisture, render it a valuable material for legal documents, such as policies of insurance, scrip certificates, deeds, agreements, &c. It is also used to replace vellum in bookbinding, and takes the place of ordinary paper in school-books, and other books exposed to constant wear. The manner in which it bears both oil and water colours renders it of value for artistic purposes; the chemist now employs it largely for the new process of dialytic analysis, and ladies use it extensively to replace bladder in covering preserve pots, &c.

But there is another class of rags—those from woollen materials—which cannot be thus employed for the purposes of the paper maker. Our readers are probably aware of the transformations which cast-off cloth garments undergo; their change into "mungo," "shoddy," and "devil's dust," and their re-appearance as "ladies' cloth;" their subsequent degeneration into druggets, and final utilization for ornamenting our walls in the form of flock paper. These we pass over, and will trace the history of woollen rags after they have thus been tortured and wrought into every textile form which the ingenuity of manufacturers can devise. The fibre of the wool may have become physically completely broken up, and disorganized by repeated treatment, but its chemical value remains unaltered, and the large amount of nitrogen which it contains is too valuable to be thrown away. Tons upon tons weight of this woollen refuse are sold for manure, and its excellent properties in this respect are well shown by the perfection of the early brocoli which is supplied so plentifully to the London market from Cornwall.

The class of goods called muslin-de-laine for a long time baffled the waste product utilitarian. The cotton fibre was valuable, and the woollen fibre was valuable, apart, but the difficulty lay in separating the two. Either of them could be destroyed by chemical means; thus, steeping the mixed fabric in acids converted the cotton-weft into sugar, when the wool was left available; and, on the other hand, an immersion into an alkali dissolved out the woollen-warp and left the cotton. But the manufacturer was not satisfied with this; he wanted both fibres; and Mr. F. O. Ward has lately introduced, and illustrated in the chemical department of the International Exhibition, a most ingenious process by which this

desideratum is accomplished. He takes the mixed fabric and subjects the rags to the action of steam at a pressure of four or five atmospheres. The effect of this is to char the wool, rendering it very friable, whilst the cotton is not in the least injured. The action over, the rags are beaten and sifted, when the cotton is left behind in the fibrous state, whilst the brittle matter into which the wool has been converted separates in the form of powder. The cotton, being as firm and as strong as ever, may be applied to a variety of purposes: some very excellent paper made of cotton separated in this manner is shown by Mr. Ward; the wool is sold as a manure, under the name of "crenate of ammonia."

But woollen refuse can be applied to higher purposes than forcing early cabbages; the chemical manufacturer, utilizing in another way the nitrogen which it contains so plentifully, throws it into his cauldron, and stews it down with pearlash, horns and hoofs of cattle, old iron-hoops, blood, clippings of leather, and broken horse-shoes — when it produces the beautiful yellow and red salts, known as the prussiates of potash, magnificent crystals of which may be seen in the Eastern Annexe. From these salts, the rich and valuable pigment, Prussian blue, is made; and under this form our old rags start upon a fresh career of beauty and usefulness, forming in their turn other waste products which are again seized hold of by skilful intelligence, and re-utilized.

We now approach the vast and important subject of Bones. The uses to which these are applied are endless. Their mechanical applications for knife-handles and similar purposes do not require more than a passing reference here, but we may state that the quantity annually imported into this country represents a money value of £400,000. Chemically speaking, bone consists of a little more than half its weight of phosphate of lime, and about a third of its weight of cartilage, the remainder being made up of earthy matters unimportant for our purpose. The applications of each of these constituents of bone are numerous: the cartilage is capable of being extracted by boiling water under pressure, being converted into a gelatinous substance, and is then used in large quantities by the calico-printer for stiffening the fabric. The substances known to housekeepers as gelatin and calf's-foot jelly usually consist of this extracted cartilage in a purified form. Isinglass is quite a different substance in its origin, although, chemically speaking, only gelatin. It is prepared from the sounds of certain species of sturgeon; and, from its somewhat high price, has long tempted manufacturers to produce an imitation in ordinary gelatin. The success which has attended this endeavour may be seen by an examination of several cases in the Eastern

Annexe. Viewed as an attempt to endow the humble gelatin with some of the elegance and refinement of its more costly competitor, these endeavours deserve all the success which has attended them; but, in the hands of some retail sellers, this legitimate imitation is often palmed off upon the public as genuine isinglass, when it assumes the character of an unjustifiable imposition.

When bones are heated without access of air, the organic matter of the cartilage is decomposed—oily products passing over and a black carbonaceous residue being left. This is known by the name of bone-black or animal-charcoal, and consists of carbon in an extremely fine state of division diffused through the inorganic constituents of the bones. Bone-black has a great affinity for several organic colouring matters, and is extensively used for decolourizing syrups, sugar, and other things. If a solution of dark brown sugar be filtered through a layer of bone-black it passes through perfectly bright and colourless; port-wine may in a similar manner be obtained as colourless as water, without its flavour being much impaired. The oil which distils over during the operation of calcining is known in commerce as "Dippel's animal oil;" it contains aniline and several other basic bodies, and can be employed for the production of colouring matters in the same way as coal-tar.

The subject of artificial manure is one which has received great attention of late years. Chemists have discovered that the earthy constituents of bones form one of the most valuable foods of plants, and to supply the soil of England with the earthy phosphates which are annually removed from it by cereals and other crops, manufacturers now not only make use of recent bones, but avail themselves of the rich store of phosphatic wealth existing in the fossilized remains of extinct animals. The so-called superphosphate of lime consists of calcined bones, or coprolites,* which have been reduced to fine powder and then treated with sulphuric acid; part of the lime is removed by this process and the remaining superphosphate is obtained in a form which is readily assimilated by plants.

The manufacture of phosphorus—"that dark, unctuous, daubing mass,"—which has now become so important and universal an agent of civilization, is the last product from bones which claims our attention. It is prepared from the phosphoric acid contained in bones by heating it to a very high temperature with charcoal. The five equivalents of oxygen contained in the phosphoric acid are removed by the charcoal, and the phosphorus distils over. The crude product is afterwards purified by distillation and squeezing through chamois

* Coprolites are supposed to be the petrified dung of reptiles.

leather. One of the largest firms for the preparation of this element, Messrs. Albright and Wilson, of Oldbury, exhibit a most interesting case illustrating this manufacture, the beautiful semi-transparent, wax-like appearance and the large blocks in which it is produced are very accurately illustrated (phosphorus itself being inadmissible in the building).

The great consumption of phosphorus is of course in the manufacture of lucifer matches; in this, two difficulties have to be contended with, phosphorus being the most inflammable body known, and also one of the most poisonous. Numerous had been the attempts to overcome these difficulties in the manufacture of this useful though humble commodity, but the liability to explosion, and the terrible disease to which the workmen who inhale the phosphuretted vapours are subject, seemed scarcely capable of being obviated, when Professor Schrötter, by one of the most remarkable discoveries in modern chemistry, effected an entire revolution in the manufacture. He discovered that when common phosphorus was heated for some time in a close vessel to a temperature of 470° F., it underwent a complete alteration in the whole of its physical characters. From a white, waxy, crystalline body, soft and flexible as lead, it became a deep red, amorphous, opaque mass, hard and brittle as glass. The white phosphorus quickly ignites by mere exposure to the air; the red phosphorus will not ignite spontaneously, and may be packed up in boxes, in the dry state, without any danger. The white phosphorus is as poisonous as arsenic, and has a strong garlicky smell, whilst the red is without odour, and has no poisonous properties. The former is luminous in the dark, and melts at 108° F., whilst the latter is perfectly illuminous, and requires a temperature above 500° F. to melt it. Lastly, the white is freely soluble in various liquids, whilst scarcely any known solvent will touch the red modification. In spite of these striking differences, the red phosphorus answers quite as well for match making as the common sort, and as the transformation may be effected with very little trouble, there is no doubt that the harmless variety will, in course of time, entirely supersede the dangerous variety.

Considering the frightful disease which attacks and destroys the jawbones of the workpeople employed in making common matches, and at the same time their highly poisonous properties, we think it the duty of every person to encourage to the utmost the manufacture of matches made from red or allotropic phosphorus. Of these, two varieties are at present before the public. One kind is exactly like the ordinary match in which the oxidizing material and the red phosphorus are mixed together, and put on the tips of the splints, differing there-

fore from the common kind only in being non-poisonous. The other variety of match is a very beautiful invention. It is called the safety match, and well deserves its name. In our last number (page 522), we gave a short notice of this invention, and we will therefore only briefly refer to it here. The oxidizing material alone is put upon the match, the red phosphorus being mixed with emery, and pasted on the side of the box; the match is therefore not a match until it is brought in contact with this friction-paper, and the splints may consequently be trampled upon and littered about the house with perfect impunity. No accidental ignition can possibly take place.

We have thus briefly sketched a few of the valuable applications of substances which some years ago were looked upon as utterly valueless. Coal-tar, rags, and bones, rise from the sewer and dust-heap, and are transformed by chemistry into costly luxuries, or necessaries of civilization, giving employment in their transformations to a large number of our working classes. Necessary limitation of our space has compelled us to omit all reference to other waste products which are now almost as extensively utilized; but an attentive examination of the magnificent and unrivalled display of chemical manufactures now collected together at South Kensington, will convince the student, that to the chemist there is no such thing as a waste product, that which is so designated being to him a coffer of untold wealth, ready to yield up its treasures to any one applying to it the master-key of knowledge.

No. IV.

THE PHILOSOPHICAL INSTRUMENTS.

BY JAMES BREEN, F.R.A.S.

SINCE the Exhibition of 1851, the improvements in philosophical instruments have been sufficiently various and important. Those which are now universally known were then undreamt of. The stereoscope has come into general use, and instead of the ghastly representations given by the daguerreotype process, we have now solidity itself pictured forth in plain black and white by the assistance of this little instrument. The collodion process, with which it has been accompanied, has reached the utmost perfection. Photographs of the solar spots

have been taken as it were in relief,—transferred by electro-metallurgy to a solid form, and, dispensing altogether with the engraver's aid, printed from in the ordinary manner. The binocular microscope has given a fresh impetus to the study of nature in its most minute and intricate forms. Telescopes, indeed, there were in abundance, and good ones too, at the last Exhibition, but they have since been exceeded in power and excellence, although, with the exception of Foucault's successful contrivance of silvering a parabolic glass surface, nothing novel has been introduced in their construction. In the matter of reflecting telescopes with metal mirrors, the movement has been retrograde; but even this, perhaps, has been judicious. At the epoch of the Exhibition of 1851, Lord Rosse's six-foot reflector was in full operation—disclosing the wonderful spiral structure of several nebulæ, resolving others, and thus connecting them, in different respects, with the form and nature of our own Milky Way. But the labour of years bestowed upon its construction, and the difficulty of keeping its polished surface in proper condition, have not been found sufficiently fruitful in results to warrant the extension of this description of telescope. Only one telescope of large dimensions has since been constructed on this plan,—the four-foot mirror of Mr. Lassell, from which, doubtless, by aid of the clear sky of Malta and the long experience of the maker and observer, great results may be anticipated. It is remarkable, that it has been the *makers* of reflecting telescopes who have been most successful in celestial discovery,—the two Herschels, Lord Rosse, Mason, and Lassell, are striking instances of this,—but the care required to keep them in working order, already alluded to, has caused astronomers to have recourse once more to the original refracting telescope, and the latter has gained considerably by the preference. Separate instruments for meridional observation (on a large scale) do not figure at the Exhibition of 1862. Thanks to the present Astronomer Royal, the transit instrument and mural circle have been united into one solid apparatus, with which a single observer can do the same work much more satisfactorily than two on the old system, and register the right ascension and declination of an object with the same ease and equal certainty as on the ancient plan.

The electric telegraph is now a domestic institution, vastly simplified, but yet capable of further improvement, particularly in the insulating of the submarine cable; for out of 14,000 miles already laid down, only 4,000 are stated to be in working order.

It would be impossible, within the limits of a short summary such as the present, to go *seriatim* through the various objects exhibited by one hundred and fifty different inventors and manufacturers. In those articles where taste and ornamenta-

tion are most in vogue, such as opera-glasses and optical toys, the British collection is as showy, and, we believe, much more solid than those of other countries. It is interesting to notice the most ordinary applications of science; how some dozens of spectacle-glasses are ground and polished at the same time—arranged and fixed around a convex or concave disc,—and how a rough lump of steel is punched and worked, until, without joint or soldering, it comes forth a spider-web frame for those lenses, such as Ariel might give, or Cinderella receive. In the higher branches of optical art, where the brain is equally potent with the fingers, we miss many names familiar in 1851. Merz, of Munich, who gained the council medal at the last Exhibition, is not represented in the present building, although, from the fine collection of telescopes which he is now constructing, he might easily have spared a specimen. Ertel, to whom, for his fine graduations, the jury awarded the great medal in 1851, but who, nevertheless, by a decision of the council of chairmen, only received the ordinary one, is equally invisible. Troughton and Simms, to whom the same thing happened, are also unrepresented; and the names of Lerebours, Secretan, and Steinheil, do not appear in the catalogue. Only one specimen of Foucault's mirrors, and this of small dimensions, appears at the present international show. The United States, which, on the last occasion, contributed so much that was new and interesting—methods of recording transits, electric telegraph apparatus, photographs of the moon—do not send a single article to classes 13, 14, or 15, and yet the excellence of Alvan Clarke's telescopes is duly appreciated in this country. Neither the large telescope of Professor Amici (Florence), of $17\frac{7}{10}$ inches aperture, nor any other of the splendid list of his scientific instruments given in the catalogue, arrived, although they had been eagerly expected, at the International Exhibition.

Still, however, enough has been exhibited to show the progress of science during the last ten years. The large equatorial made by Grubb, of Dublin, strikes us by the solidity and convenience of its fittings; the diameter of the object-glass is twelve inches, and, should it be worthy of the mounting, will certainly make a noble instrument. The mere metal-work is, however, a subsidiary affair in a telescope—what is most required is perfect and colourless definition, and this is only to be attained by the purity of the glass and the accurate form and complete polish which the artist bestows upon the four spherical surfaces of the crown and flint lenses. The finish of Cooke's instruments is well known. His principal one is a telescope of eight inches aperture, equatorially mounted and furnished with a very solid base. The conveniences for motion in right ascension and declination are excellent; the hour circle is moved by

clockwork, which, as he is also an exhibitor in the department of Horology, may be expected to be perfect. This apparatus, whilst in motion, keeps the telescope always pointed to the same celestial object. The other telescopes which he exhibits are smaller, but the fittings and brass-work are in all cases very fine. Dallmeyer exhibits some astronomical telescopes in which the stand and slow-motion apparatus are very commodious. Wandering about the cases in the gallery, we perceive many fine telescopes of from one to five foot focus, and fixed on stands of all descriptions—nothing novel in design, although perfect in manufacture. Of the object-glasses (which are not exposed to view) we can form no opinion; but, considering their small size and the consequent ease with which they are made, it is almost certain that they are in all respects equal to the instruments of which they constitute so important a part.

The gem of the Exhibition, in this department, is the great 28-foot telescope belonging to J. Buckingham, Esq., C.E., who has fitted it up for his own private use, and has himself devised and manufactured all its various and novel machinery. The object-glass of twenty inches aperture is the largest *successful* attempt that has hitherto been effected. It is the work of Wray, and has been ground and polished to the true curves by his improved methods; speaking admirably for the perfection of the system, as the surface does not show the least *grain* when examined with a microscope, and the chromatic and spherical aberrations are quite corrected. Whilst amateurs and observers have worked their own mirrors with *one* surface, it has been reserved for opticians *proper* to produce the perfect object-glass of *four* or even *six* surfaces. Few can conceive the difficulty of producing an achromatic lens of twenty inches diameter—the slightest deflection from the true figure, produced by an extra stroke of the polisher, renders the glass quite worthless. It may be stated that the most powerful refractor hitherto in use (if we except that made, during the present year, by Alvan Clark, of 18½ inches) is the 16-inch, by Merz, at Pulkowa; but the light-grasping power of this latter (varying as the squares of the diameter) is only as 256 to 400, in comparison with that here exhibited; so that when the present instrument is brought into operation, we may expect many discoveries to be made in the constitution of those faint nebulæ which Lord Rosse has rendered celebrated. This telescope has as yet been comparatively untried, but it is to be hoped that the vast amount of skill, labour, and capital employed in its construction will lead to many important results. The method of mounting is very commodious—all the clamping and slow motions can be effected from the eye end, and the

declination circle is intended to be read off from the same part. In the same case in the gallery in which this great object-glass is exhibited, there are other specimens of lenses, also ground and polished by Wray, all of which (including a 9-inch and 5-inch glass) have been equatorially mounted by Mr. Buckingham for his particular use. The simplicity and steadiness of the portable stand, and the beautiful workmanship of the 7-foot telescope, will be much admired. We may congratulate Messrs. Buckingham and Wray upon their remarkable success in this branch of optics, and upon the introduction into England of a perfection in telescopes, both as regards size and capability, which had hitherto been monopolized by the Munich artists.

The difficulty of obtaining a fixed position, either for an observer or his instrument, on board a rolling ship, has often been endeavoured to be rectified, but hitherto without success. Chairs, suspended like a chronometer in numerous gymbals, have not been found sufficient to give the necessary steadiness. Peg-tops, with a plane mirror on the upper part, spun on the deck of a ship, have been used in order to give a fixed horizon. Professor Smyth has turned the gyroscope, or rather the principle of free rotation, to account in an instrument constructed by him, and tried with success on his journey between Leith and St. Petersburg. With this gigantic instrument, which required to be set in motion by the combined action of all hands on board ship, he was enabled to keep an instrument directed to any heavenly body notwithstanding the rolling or pitching of the vessel. The utility of this invention will be readily understood by those who have endeavoured to observe the occultation of a star or of Jupiter's satellites on the deck of a sailing or steam vessel. With a similar apparatus he is able to register the degree and effects of all those motions, or to show any two of them combined.

When Oersted perceived (in 1819) that a magnetic needle suspended freely could be turned to one side by the transmission of the electric fluid passing through a wire parallel and near it, no matter at what distance the battery was placed, the telegraph was virtually discovered. It took long years, however, to realize this invention; to find a fitting battery; a perfectly insulated wire; a convenient code of signals. During the few years previous to the Exhibition of 1851 this science made immense progress. Not only were telegraphs then transmitting messages, but actually printing them on ribbons of paper, and the electric current had even been used in recording the passage of a star across the wires of the transit-instrument; thus throwing the ear out of employment altogether, and bringing the sense of touch into operation instead. Since that time the principal endeavour has been to simplify the alphabet, to obtain

a good working electric current—to have a perfectly insulated line of wire, which, by their united action, would supplant the letter-carrier and take the place of the Semaphore, equally regardless of tide, storm, or hazy weather. The labours of Bright, Walker, and Wheatstone have resulted in a degree of excellence which can scarcely be surpassed; one has only to enter the nearest telegraph-office and have his message transmitted to the most distant county of England in a few moments, in order to be apprised of this fact. Further economy in the working, and still greater celerity, appear, however, to be the aim of the telegraph engineer. In one respect these endeavours must command our liveliest sympathy. The most simple system of train-signalling will assuredly be found to be the best not only in the working but in the less liability to get out of repair. Tyer exhibits an instrument which can be worked by the most unskilful hands, and by means of a gong, a bell, a red indicator and a black indicator, gives all the signals having reference to the safety of the train, and cannot by any possibility be mistaken. One condition necessary to be observed, and which, if strictly adhered to, would prevent numerous accidents, is that "no signal is to be considered complete until the reply has been received." Allan exhibits his Automaton Telegraph, in which several novelties are introduced. In the first place, any person sending a message intended to be confidential, and having the cipher in his possession, punches the dots separately on a ribbon of paper at the signalling-office, and this paper being passed over the tooth of a small rotating spur wheel, electrical contact ensues at the different punctures, which is duly answered by a similar puncture on a similar ribbon of paper at the *receiving* office. By this method it will be seen that the signalling or recording clerk is no longer necessary,—the slips of paper are put into the machine at one office and are instantaneously reproduced on the paper at the other extremity. The punched hieroglyphics are delivered to the person for whom they are intended, and the telegraph clerk is completely ignorant of the purport of the message. Both the positive and negative electric currents are used for marking, thus causing a saving of 30 per cent. in the number of currents sent through the wires. In Allan's composing-machine the Morse system of dots and dashes is altogether rejected, and the system of dots alone made use of—the number of dots forming any letter being punched on the ribbon at a single operation by merely touching one of the thirty keys of an instrument arranged like a piano. One of the particular advantages which the system possesses is that the ribbon of paper at the sending end may be passed through the apparatus several times, always reproducing a similar one at the receiving extremity, and may thus be a

source of economy where numerous copies of the same despatch are required to be delivered at the same time—as, for example, at various newspaper offices. The various letters are, however, sent as rapidly by Henley's more simple machine, which prints by dots and dashes. Probably, Hughes's American printing telegraph, in which the letters are printed in Roman type at once, will eventually come into general use.

Of all the numerous trophies in the nave of the Exhibition, the holophotal light-house revolving apparatus of Messrs. Chance is the most dazzling, and one regrets that there is not an opportunity of witnessing the flashes of light which it would send forth were the building in a state of darkness, and the great lamp at its centre duly burning. How different from the first attempts at light-houses—where a fire of flaming coal or wood warned the mariner of his approaching danger, or even from the feeble light of a few candles, without either metal-reflector or "bull's-eye," which for half a century surmounted Smeaton's noble structure. Each of those curved and annular prisms and lenses are ground and polished with mathematical exactness in order to reflect and refract, and so economize every ray of light proceeding from the four concentric-lighted wicks, and send them far and wide round the horizon. With one of those massive glass cages the light may be seen at a distance of thirty miles. The dioptric light-house apparatus, although often thought of, has only been successfully realized within comparatively few years, and that mainly through the exertions of Fresnel. The combination of metal reflectors and lenses proposed by that eminent philosopher, who busied himself as much with the humble improvement of the lamp itself as with the deeper researches on the form and arrangement of the lenses, is, however, here much simplified, and glass is made to perform the whole duty. The perfection to which the manufacture of this material has been carried, and the improved plans introduced by Mr. Stephenson in the arrangement of the prisms by which the divergent rays of the flame are gathered up and distributed in one uniform horizontal beam, have fully proved the excellence of the change. The lantern revolves on its axis by means of clockwork machinery, which keeps an uniform rate of motion, and by the number of flashes emitted the sailor is able to tell the name of the particular lighthouse to which he is near. Among other articles exhibited by this firm, we might point attention to the discs of glass of twenty-five inches in diameter, prepared for optical purposes, and from which it is to be hoped that, if perfect, they may speedily be worked up into the object-glass of a large refractor.

When magnetic observatories were first established, it was

necessary for an observer to be constantly in attendance, in order to register the different fluctuations of the magnets. Mr. Brook hit upon the happy idea of applying the photographic process to this end, and at the last Exhibition his apparatus for this purpose was in full work. Similar machinery, as arranged by the late Mr. Welsh, and now in use at the Kew Observatory, is here exhibited, and it will be seen with what simplicity the light coming from one fixed, and another hemispherical mirror, attached to the magnets, impresses two images on a waxed paper photographically prepared—one of which gives a fixed line, and the other, of course, moves according to the oscillations of the magnets, the distance between the two showing the amount of the latter. This principle has also been applied to registering the fluctuations of the barometer and thermometer, and is preferable to any other, —in the former case, being much more safe and simple than the numerous self-registering mechanical apparatus here exhibited, for showing the height of the mercury during the twenty-four hours, in all of which friction takes place more or less.

The ozonometer of Dr. Lankester is an ingenious adaptation of the same self-recording principle, only that, in this case, it is the life-giving properties of the atmosphere (and not solar or artificial light) which leave traces on the prepared paper. The effect of this element is shown in a large diagram, drawn up by the same authority, representing the various tints of slips of paper exposed during different states of the weather; and to the meteorologist this is as useful, and should be as strictly attended to, as the weight, temperature, or humidity of the atmosphere. To those who have used the ordinary maximum thermometer, with an index floating on the mercury, which is only too liable to get out of order, the self-registering maximum thermometer of Professor Phillips, consisting of a broken column of mercury, will be a great boon. The mercurial minimum thermometer, of Casella, is another great improvement; in this case advantage is taken of the adhesive property of mercury for glass in vacuo, and also of the fact, that when two tubes are joined to one bulb, the mercury will rise in the larger by expansion, and fall in the smaller by contraction. He therefore makes a branch, *d*, to the ordinary thermometer, having a flat diaphragm at *b*, the inlet to which is *larger* than the bore of the long tube, *c*. The mercury in cooling withdraws the fluid in the indicating stem only, whilst on expanding, it flows into the passage where it finds the least resistance; in other words, the mercury in the long tube cannot

rise, but *will* fall. Mr. Johnson shows a novel instrument for registering deep-sea temperatures, where advantage is taken of the different degrees of the expansion of metals. Riveting two thin pieces of brass and steel together, he has contrived means to register the effects of the small curvature which the combined metals must undergo by a change of temperature. By this method the pressure of the sea on the bulbs of self-registering thermometers is got rid of, which is quite destructive of delicacy at immense depths. The same gentleman shows his instrument for recording deep-sea soundings, in which the fact that water is slightly compressible is ingeniously applied.

MM. Negretti and Zambra exhibit a deep-sea sounding thermometer on quite a different construction to that of Mr. Johnson. In their instrument the bulb of the thermometer is enclosed in a second cylinder partly filled with mercury *in vacuo;* the pressure of the water at great sea depths exercises its influence on the latter—the internal bulb being quite free from pressure on this account.

Of the ordinary instruments of science—microscopes and microscopic preparations—the collection shown in the French and English departments is excellent. It would be invidious to point out any one maker among so many known to fame. Single and binocular and museum microscopes are here—from the cheapest to the most expensive and complicated forms. We may say the same of all the ordinary surveying, nautical, and drawing instruments, such as theodolites, sextants, compasses, and levels. Among the newly invented microscopical apparatus, the visitor will perceive, in Ross's case, the hemispherical condenser of the Rev. J. Reade, from which, by means of double stops and hemispheric lens, one, two, or three apertures may be obtained, and the linear markings, no matter at what angles, on test-microscopic objects, obtained by means even of an ordinary microscope. The application of aluminium to small telescopes and other instruments intended to be held in the hand, renders them very commodious; a sextant here exhibited, only weighs one-half of a similar one constructed of the ordinary metal. A contrivance for facilitating the approximate solution of problems in spherical trigonometry (exhibited by Moore) will be found useful to the seaman. The apparatus for spectrum-analysis invented by Crookes has now become one of the necessities of the laboratory and the observatory, and replaces the simple prism and theodolite originally made use of by Fraunhofer. We trust that the inventor may soon set at rest the disputed question of the spectra of stars which has within the last few months so much engaged the attention of astronomers.

In some departments and countries the chronometers are

ranged under the head of Philosophical Instruments. This is by no means a mistake, for to the weatherwise, the star-gazer, and nautical man, a good chronometer is as essential as scales, weights, and measures to the chemist. Two of our greatest living astronomers, Professors Hansen and Bond, were originally in this profession.

Whilst the English department is full of the admirable mechanism and inventions of our Dents, Bennetts, Frodshams, Losebys, &c., we perceive that other countries have not been behindhand. Germany has adopted Hartnup's excellent balance. Hohwn, of Amsterdam, exhibits a compensation of his own invention, whilst a small pocket chronometer, of exquisite workmanship, exhibited by Baume and Lezard, which has been compared at the Geneva Observatory, appears to have kept its rate with extraordinary accuracy, and reflects great credit on the manufacturers. The ships' chronometers of Grandjean also show the progress which this branch of manufacture has been making in Switzerland, where goodness and cheapness are combined. The nautical astronomer here finds plenty to engage his attention in every department of his occupation.

MISCELLANEA.

THE ALBERT MEMORIAL.

THE Commissioners appointed by her Majesty for the purpose of erecting a monument in memory of the late Prince Consort have decided, after mature deliberation, and amidst the expression of the most conflicting opinions, to raise a suitable memorial group, which is to be placed in a building to be devoted to purposes of science, art, and literature. This determination will, we believe, meet with the cordial approbation of all who know anything of the desires and aspirations of him in whose honour the memorial is to be erected; and such a monument will present a suitable contrast to the numerous obelisks, needles, and statues which have from time to time been raised to the memory of the wise and good.

We have but one observation to make upon the project, which has our best wishes for its success.

If the building and its adjuncts be so ordered as to be useful to the metropolis only,—in fact, if its vital functions, so to speak, are to be purely metropolitan, well, then we wish it may prosper, and that the inhabitants of London and its vicinity will give it every support and countenance.

If, however, it is to be *national*, and if provincial towns (where encouragement to science and art is so much needed) are to participate in its advantages, and it is destined to form a great centre to the scientific and other associations which desire to be interlinked with it,—then we not only hope, but feel very confident, that it will meet with support from every town in the British empire, however large may be the sums that have already been subscribed or voted for local memorials; and then, indeed, it will become a fitting monument to the memory of the good Prince whose life and acts it is designed to perpetuate.

OUR SCIENCE SCHOOLS AND CLASSES.

THE zealous and efficient teachers whose services have been enlisted in the cause of Science, chiefly in consequence of the tempting inducements held out to them by the Committee of Council on Education, have just cause to congratulate themselves, and to look with pride upon the results which, year after year, are being attained through their agency.

Mr. Ralph Tate, of Belfast, for example, who appears to possess as great tact in giving direction to the intellectual efforts of his students, as he does ability to teach science, will have no cause to regret having undertaken his task, when he counts up the numbers and achievements of his "passed" pupils.

So far as the published records of the Department of Science and Art indicate, his class appears to have existed only one season, during which time his teaching has been most efficient, and the industry of his students highly creditable; for eighty-two of them have passed the government examination in

geology and mineralogy, and of these, eleven have carried off first-class Queen's prizes in geology (out of thirteen granted all over the United Kingdom), twelve second-class, and fourteen third-class; thirty-seven prizes in all. In mineralogy they have taken twenty-one prizes, six of which are of the highest grade.

Amongst his pupils are men and women, boys and girls, of almost every age, profession, and calling: clerks and their sons and daughters; young women in shops; tradespeople and their apprentices; children of operatives, and operatives themselves; national teachers, Methodist ministers; miners and their sons; indeed it would be difficult to name a trade or profession which is not included in the list of his pupils; and it is a feature worthy of special attention that the most successful have been girls, who have carried off many of the highest prizes.

All these young people constitute so many missionaries who will diffuse a taste for science amongst their friends and relatives, and many of whom will no doubt in their turn become successful teachers.*

Equally, or perhaps still more successful in the results of his teaching, is Mr. John Dowling, of Cork (our Irish friends certainly put us a little to the blush on this side of the Channel), whose pupils carry off no less than sixty prizes; including fifteen of the highest grade in inorganic, and nine in organic chemistry, the remainder being of lower grades in chemistry, and various prizes in the different subdivisions of geology and natural history.

Pleasing as such a task would be to us, and however richly our science teachers deserve to have their individual successes everywhere recorded, their numbers prevent us from doing them this act of justice; but as far as we are able, we shall afford to their success that publicity and recognition which it deserves, by appending to this article a list of those gentlemen whose pupils have taken first-class Queen's prizes, with the name of the town in which each resides, and the subject or subjects in which his pupils have been successful. We also add the names of those students whose talent and assiduity have enabled them to carry off the gold medals; and the names of their teachers.

The most successful schools and classes appear to be those in Cork, Belfast, Huddersfield, Wigan, Banbury, Gloucester, Truro, Bristol, Manchester, Oldham, Accrington, Liverpool, and London.

We must, however, repeat the regret expressed in our last article on this subject, that the large towns, such as Birmingham, Manchester, Leeds, Hull, &c., are, comparatively speaking, far behind their smaller neighbours, and we do so notwithstanding a protest which we have received from Birmingham, but which, unfortunately for the protester, fully corroborates what we have stated on the subject.

In our number of last January we said, that whilst in such places as

* So far, we believe, no females have attended the November examinations at South Kensington for the purpose of graduating as teachers; and we again earnestly recommend this subject to the consideration of the Committee of Council on Education. If it be found impracticable to afford an asylum to young girls desirous to visit London for this purpose, it would be no difficult matter to let them pass the teacher's examination at the science school nearest to the place where they reside; and this could be done in May, when the general examinations of students take place throughout the kingdom.

Dedham, &c., there were *classes*, and *schools* in Banbury and Wigan, yet there were not even classes in Leeds and Hull; and that in Manchester and Birmingham a commencement had only been made by individual teachers, but that there are no recognized *public schools*. To this statement our Birmingham correspondent takes exception, affirming that science classes have been established in connexion with the Midland Institute since 1854, and the writer seems to think that they have been successfully conducted.

So far as the expression, "recognized public schools," is concerned, we may say, that although it was intended to refer to schools specially devoted to science-teaching only—"science schools," in fact—we must apologize for not recognizing the connexion of the science classes with so valuable a public institution as the Midland Institute, concerning whose operations we treat elsewhere at greater length;* but as regards the more important part of our statement, namely, the position occupied by Birmingham (amongst other places) in the movement, we are bound to confess that a comparison of the details given by our correspondent, with the results of the recent State Examinations, shows that, however humble the position of this important manufacturing town was in 1861, it appears this year to have retrograded still further. With all the resources of the Midland Institute, at which, our correspondent tells us, "800 pupils are receiving class instruction," and notwithstanding that the science classes have been in existence since 1854, only twelve students passed the government examination this year, of whom four have taken inferior prizes. A comparison, moreover, of the results of this with those of last year reflects very unfavourably, in other respects, upon the condition of these classes. We cannot suppose that the teacher is responsible for this state of things, for he holds high certificates, and is spoken of in terms of praise by the committee.

Having been compelled to say thus much (and we might have said more) in defence of our position, we may now add that we feel sure that if greater publicity were given to the advantages to be derived from joining the science classes, and if our correspondent would exercise his influence (which is not inconsiderable, for we understand that he takes the lead in all intelligent and progressive movements in Birmingham) in their favour, a science school would spring up and flourish in his town, which would be second to none in the kingdom.

The new school, inaugurated by Earl Granville, in Liverpool, last autumn, has been moderately successful; for although the session was a short and imperfect one, forty-three out of about a hundred students presented themselves for examination; of these forty-one passed, and seventeen took prizes of various kinds, chiefly, however, as might be expected, of the lower grades.

In the first and second Numbers of this Journal we drew attention to the advantages, pecuniary and otherwise, derivable from a connexion with the department of Science and Art, by teachers and students of science; and feeling that too much publicity cannot be given to the benefits offered to those who are disposed to join in this excellent movement, we will once more refer to the career which lies before those who possess and feel disposed to take advantage of scientific attainments; and it must be clearly understood

* See "Provincial Institutions and Societies."

that the following remarks apply to young persons of *average* ability; for there is no limit to the success of a very able and persevering teacher.

Let us suppose that a young man of eighteen joins a science school in his town, and that, taking up a single branch of science—Zoology and Animal Physiology—he attends two or three courses of evening lectures.* He must be very dull indeed if he does not succeed during this period in obtaining first-class prizes in both subdivisions of his subject (to say nothing of bronze, silver, or gold medals), and he may then aspire to become in his turn a science teacher. This he does by passing his examination on the subject in question at South Kensington, Government paying his travelling expenses and the cost of his living in London.

Here he may obtain a first, second, or third class *teacher's* certificate; and should he not be satisfied with one of a lower grade, he may "improve" it by presenting himself (always at the expense of the State), time after time, until he fairly succeeds in securing a certificate of the highest grade, and the emoluments accruing therefrom.

Our candidate has, we will suppose, after two or three examinations, secured a first-class certificate in Zoology and Animal Physiology (having meanwhile conducted a small class, and received the grants which accompany one of a lower degree),† and, as we have hardly treated him in a complimentary manner, in supposing such repeated efforts to be needful in order to secure a first-class teacher's certificate, we will take it for granted that, during his probation, he has also obtained one of the *second* degree in botany and Vegetable Physiology; and that he has a small class, say of ten pupils in each subject, four or five of whom have passed the government examination, and three have obtained respectively a first, second, and third class Queen's prize in each subject. During the year, when he shall have obtained these not very brilliant results, he will be entitled to draw from the coffers of the Treasury the sum of £42, besides charging what he may consider fair to each of his students, or receiving a salary from the institution with which his classes are connected.

And all this he may effect—his scientific education, as well as his teaching operations—without the slightest interference with his business pursuits, but only by a wise and elevating employment of his leisure time. So much for the exertions of a young person of ordinary abilities. A successful teacher may earn hundreds of pounds per annum, and may (as many doubtless will) at the same time attain a high position in society and in the State.

With these few remarks we once more dismiss this important subject, and should any of our readers be desirous to aid the movement, either as teachers, students, or promoters of schools or classes, they will receive every needful information on applying to the Secretary of the Science and Art Department, South Kensington Museum, London. As for ourselves, we shall be most happy to give the scheme itself, or the efforts of individual teachers, every encouragement in our power, and we invite the various institutions to forward us their reports whenever they may deem it to their advantage.

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* His fees, text-books, &c., will cost him *in all* from 10*s.* to 30*s.*, according to the charge made by the committee of the school which he attends.

† Under the new Code certificates of every grade are alike remunerative.

LIST OF SCIENCE TEACHERS

Whose Pupils obtained first-class Queen's Prizes at the last Government Examination.

Teachers' Names.	Address.	No. of Prizes.	Subject or Subjects in which the Prizes were taken.
Angell, J.	Manchester	9	Animal Physiology; Inorganic Chemistry.
Beale, J. H.	Banbury	1	Animal Physiology.
Beesley, T.	Banbury	2	Inorganic Chemistry.
Bentley, B.	Huddersfield (Kirkheaton)	1	Inorganic Chemistry.
Bernhardt, G.	Manchester	2	Geometry (practical, plane, and descriptive).
Birkenhead, E. H.	Wigan	4	Inorganic Chemistry; Mineralogy.
Burchett, R., and Binns, W.	Chester	1	Geometry (practical, plane, and descriptive).
Chadwick, J.	Macclesfield	1	Inorganic Chemistry.
Clement, L.	Burnley	1	Inorganic Chemistry.
Collingwood, Dr.	Liverpool	1	Zoology.
Coomber, T.	Bristol	4	Theoretical Mechanics; Inorganic Chemistry.
Crossley, W.	Middlesbro'-on-Tees	2	Inorganic Chemistry.
Dorrell, J.	Slough	3	Geometry (practical, plane, and descriptive).
Dowling, J.	Cork	27	Mineralogy; Animal Physiology; Vegetable Physiology; Economic Botany; Organic and Inorganic Chemistry.
Eardley, F.	Belfast	3	Magnetism and Electricity.
Easterby, W.	Ripon	1	Theoretical Mechanics.
Hall, T.	London	4	Theoretical Mechanics; Magnetism and Electricity.
Hoffman, Dr.	London	2	Organic and Inorganic Chemistry.
Hudson, Fearnside	Manchester	2	Inorganic Chemistry.
Hudson, W.	Manchester (Eagle Foundry)	1	Building Construction.
Jarmain, G.	Huddersfield	6	Geology; Organic and Inorganic Chemistry.
Jeffery, W.	Gloucester	8	Magnetism and Electricity; Inorganic Chemistry.
Lindsay, A.	Glasgow	1	Animal Physiology.
Maver, D.	Aberdeen	2	Theoretical Mechanics.
Mayer, J.	Glasgow	5	Animal Physiology; Inorganic Chemistry.
Meaden, H. P.	Haslingden	9	Inorganic Chemistry.
Mellor, J.	Manchester (Hollingwood)	3	Building Construction; Geometry.
Mortimer, Dr.	London	3	Magnetism and Electricity; Acoustics, Light, and Heat.
Noble, J.	Halifax	2	Organic and Inorganic Chemistry.
O'Neill, C.	Salford	6	Organic and Inorganic Chemistry.
Pearce, R.	Truro	1	Mineralogy.
Penny, Dr.	Glasgow	2	Inorganic Chemistry.
Rowden, W.	Bristol	10	Mineralogy; Geometry; Mechanical Drawing.
Rüntz, J.	London	1	Inorganic Chemistry.
Tate, R.	Belfast	19	Geology; Mineralogy; Inorganic Chemistry.

The pupils of nearly all these gentlemen have taken lower prizes also.

Revised Regulations of the Science and Art Department.

Since the foregoing article was written, we have received a revised code similar in its intention and operation to that which recently caused such excitement amongst "elementary" schools. The changes proposed are as follows:—1. As regards *teachers, a substitution of payments on results for certificate money.* Under the old regulations, teachers were paid a sum of money upon each certificate which they held; this sum varying according to the grade of the certificate, and the number of pupils passed, up to a certain number. Thus, for example, if a teacher held a first-class certificate in Zoology (and subdivision), and a second-class certificate in Botany (and subdivision), he would receive on the former *up to* £20, and on the latter *up to* £15, at the rate of £4 per head on his students who had passed the Government examination in any subdivision of the subjects taught by him. In fact, he would be expected to pass nine students in *some* subject or subjects. In addition he would receive £1, £2, or £3 per student who took a Queen's prize, according to the grade of that prize.

Under the *new* minute the *grade* of his certificate is immaterial; for a teacher holding a third-grade certificate is placed on the same level, or, at least, is paid in the same ratio as one who has a second or even first-class certificate. Under this *régime* the teacher is to receive for *every* student who passes in *each* subject in which the teacher holds a certificate, £1; for every one who is "honourably mentioned" (a new distinction), £2; for every one who takes a Queen's prize, £3, £4, or £5, according to the grade of the prize; but in no case can he receive more than £5 on any one student.

The following statement will exhibit the operation of the change:—

A B holds Certificates—	Value under old Minute.	No. of Pupils to be passed under old Minute.	No. of Pupils under new Minute.
Botany and Veg. Phys. 1st Grade	£20	Fourteen in any subject.	Fifty-five in any subject, or twenty-eight "honourable mentions."
Zoology and An. Phys. 1st Grade	20		
Geology, 1st Grade	10		
Mineralogy, 2nd Grade	5		

On the other hand, should the teacher pass a hundred pupils under the old minute, he would only receive £55; but under the new minute he would get £100; or if he passed fifty with credit under the old minute, without their being able to obtain a prize, he would still only obtain £55; whilst under the new, fifty with "honourable mention" would secure him £100.

The prize-money appears to remain the same in both cases.

In certain cases, science may now be taught in elementary schools, which was before prohibited.

The results of the change are so obvious that it appears almost unnecessary to comment upon them.

Under the old regulations the *pecuniary interest* of the teacher would be to take as *many* and as *high* certificates as possible; and to pass only sufficient students (in any subject that was most convenient) to secure him the value of those certificates. Good teachers would be *created*, but without a

guarantee that they would teach the subjects upon which they claimed their annuity. This is corrected by the new regulations, which, whilst they still hold out inducement to teachers to become proficient *as teachers*, afford a guarantee to the tax-payer that he is receiving value for his money.

On the other hand, it seems to us that the new code is calculated to lower the *tone* of the movement whilst extending its sphere.

The holders of certificates of all grades being now placed on the same footing, there is no moral nor pecuniary inducement to young men to become proficient in scientific knowledge beyond what is needful for teaching purposes; and men already eminent in science (whose support it is even now difficult to enlist) will probably have greater objections than before to co-operate in the movement.

Again, as it will be the interest of teachers to pass as many pupils of the industrial classes as possible, so it will be the aim of committees to secure the largest attendance of these, even if they must give gratuitous admission. And, although this may serve the end of diffusing useful knowledge amongst the masses, yet it will militate strongly against the foundation of a "self-supporting system of scientific instruction."

However, the operation of the code will soon decide which predominate, its advantages or its disadvantages, as compared with the old code, which has already effected so much good throughout the three kingdoms.

LIST OF GOLD MEDALLISTS.

Science Examinations, May, 1862.

PRACTICAL, PLANE, AND DESCRIPTIVE GEOMETRY, MECHANICAL AND MACHINE DRAWING, AND BUILDING CONSTRUCTION.

Student's Name.	Age.	Residence.	Name of Teacher.
William H. Parker	18	Bristol	William Rowden
MECHANICAL PHYSICS.			
*E. P. Scrymgour	17	London	Thomas Hall
EXPERIMENTAL PHYSICS.			
Jos. G. Clarke	17	London	Dr. Mortimer
CHEMISTRY.			
B. H. Demery	30	Cork	John Dowling
GEOLOGY AND MINERALOGY.			
*John Granger	31	Belfast	Ralph Tate
ANIMAL PHYSIOLOGY AND ZOOLOGY.			
Charles Taylor	12	Banbury	J. H. Beale
BOTANY.			
*W. W. Tyler	26	Coventry	—

* Those marked with an asterisk are ineligible to receive the medal, being middle-class students over seventeen years of age.

PROVINCIAL INSTITUTIONS AND SOCIETIES.

"LECTURES don't answer," is a remark which we have heard so frequently, that we have almost been induced once or twice to think that they do *not* answer.

A little reflection, however, has shown us, that although some lectures do not, and never will succeed in attracting popular attention, yet there are others, adapted to the tastes and requirements of the public, which have always been tolerably successful and will become more so year by year.

We cannot, in this place, enter upon the reasons for the failure of so many lecture societies, variously known as "Mutual Improvement" societies, "Literary," "Scientific," or "Philosophical" institutions; but it may not be out of place if, before commenting upon some of the numerous reports which lie upon our table, we point out a few of those causes of declension (not of the societies to which we shall refer) that are overlooked by "indefatigable" honorary secretaries, and which dishearten so many zealous promoters of our literary or scientific establishments.

Should any of our remarks be unpalatable to persons who are interested in such societies, we trust that no light or unworthy motives may be imputed, but that credit will be accorded to us for desiring to see the efforts of the young and earnest philanthropist successfully directed.

The courses of lectures that we have found to be the most ephemeral are amongst those desultory ones which are offered to the dwellers in the suburbs of large towns, and villages possessing a commodious school-room.

Lectures of this order have generally for their object the withdrawing of the mechanic or day-labourer from the public-house, and the enlightenment of the sober and industrious artisan.

But let us inquire of any thoughtful person, who is initiated into the working of such societies, in how many instances they are really calculated to effect their object.

To speak within bounds, we think that one half, at least, of all the discourses delivered by inexperienced amateur lecturers are treated better than they deserve when they are "listened to throughout with attention by a respectable auditory;" and it is not a matter of surprise to us that they so frequently afford suitable food for the satirist and novel writer. They represent the waste steam of men whose whole time is spent in worldly pursuits, and who see, or imagine for the time being that they see, in some favourite hero or imperfectly-studied subject, a theme with which they will be able to electrify their neighbours and reform all idlers and dissolute characters in their parish. But such persons know nothing of the character and pursuits either of the intelligent or of the intemperate working classes.

Amongst the former, it would not be difficult to find many who are better able to compose essays upon the subjects treated by our amateur lecturers than are these themselves; and, still more, who, after a hard day's work, prefer staying at home at the season when such lectures are usually delivered, there to enjoy, in the society of wife and children, a "spell" at the *Leisure Hour* or some other cheap "weekly;" a pipe and glass of ale or cup of coffee; or a laugh at the sallies of *Punch* or Lord Palmerston; to the dis-

agreeable alternative of tramping half a mile or so in the rain and snow, and sitting two hours in a damp, ill-ventilated school-room, listening to the crotchets of some gentleman who has probably pirated no inconsiderable portion of his lecture from one of the very publications referred to, and now retails it second-hand in his own improved phraseology.

To us, it augurs well for the "lecture movement" that so many persons are found willing to sacrifice the comforts of home for the purpose of encouraging a well-intended effort to educate their benighted comrades. As to the last-named, they do not hesitate to turn their backs upon such entertainments, which they consider "dry work" compared with the "snug" and its excitements, found in the records of the police or divorce courts, or in the arguments and wise saws of the pot-house politician.

Again, we say, our readers must not suppose that we are decrying those excellent institutions which spring up, here and there, in opposition to the public-house. We are well aware that it is a matter of life and death with which we are dealing, and are determined not to regard it, as do many well-intentioned persons, as one of mere sentiment; but when, on the one hand, we observe, with dismay (as we have unfortunately good opportunities of doing), how the palaces of sin and misery multiply, like gaudy and soil-exhausting weeds in the midst of the young corn, or like great gilt cars of Juggernaut, under whose wheels the infatuated victims cast themselves by thousands; whilst, on the other, we see how ineffectual is the antidote provided against such evils,—the ever-growing strength and stability of the one, and the feeble counteracting influence of the other,—we deem it incumbent upon us to proclaim the causes of failure, even if we are unable to supply a more efficient remedy.

Concerning this, we may have more to say on some future occasion; meanwhile, we can suggest what appears to us a slight improvement upon the system with which we have cause to find fault; namely, the substitution of readings for lectures where suitable lecturers are not obtainable. If the gentleman whose original effusions result only in the production of so much waste-paper, would retire quietly to his study, and, taking up some work of acknowledged merit,—it matters not of what description—poetical, historical, philosophical, or scientific,—nay, even a weekly journal; if he would read and rehearse this carefully twice or thrice, so as to avoid errors in public, he could not fail to afford pleasure to his hearers, for it is always agreeable to listen to a well-read and well-written composition; and he would, moreover, be diffusing a taste for sound standard literature. We believe that, wherever pleasing readers have come forward to provide such entertainments for their neighbours, the movement has proved successful.

And, again, irrespective of those clever professional lecturers who can at all times attract a goodly number of listeners, rivet their attention and send them home thinking and determined to learn something more than they knew before, there are many persons who, if they would take the trouble to *prepare themselves carefully*, might entertain and instruct a large audience (provided, of course, that they are fitted by education to appear as lecturers) by simply speaking about what they thoroughly understand, or ought to understand; namely, *their own business.*

Let the engineer explain the principles of "Steam Navigation;" the lapidary

treat of "Precious Stones;" the soda-water maker, of "Soda-water Manufacture;" the builder, of the "Principles of Roofing;" the photographer, of "the Chemical Agencies of Light;" the chemist, or analyst, of the "Outlines of Chemical Analysis;" the artist, of "Perspective-drawing Instruments;" the glass-dealer, of "Ornamental Glass," and so on. To do this successfully might necessitate a better acquaintance, on the part of the lecturer, with the principles of his business or profession; but this, our readers will agree with us in saying, would be as advantageous to himself as it would be desirable for his hearers' sake. In recommending such a course, we are not only guided by our own experience of what we have known to be interesting to the public, but we are proposing that each one should, in his own humble way, follow the example set by many of our most successful institutions; namely, descend from high-flown, theoretical, and often speculative themes, to the every-day life of his hearers, and seek to create a fresh interest in those objects which come under their daily notice, and are passed by as unworthy of consideration.

The subjects above named, for example, form part of the course delivered before the chemical section of the BIRMINGHAM AND MIDLAND INSTITUTE, one of the most thriving and successful institutions in the country, and, in the pamphlet before us, we find that this section is reported as "still going on prosperously."

Glancing a little lower down, on the same page, we notice that "the Penny Lectures" were attended during the winter term by 117 persons, in spring by 69, and in autumn by 160; and, in the words of the Report, "that the increase of attendance during the current term is mainly due to the subject, 'The Outlines of Chemistry,' which is the most popular."

These outline lectures, it would appear, are "arranged to serve as an introduction to the courses in the class, the 'Penny Lecture' course terminating just before the new course in the class commences." In this extract the reader will find another reason why certain lectures answer when others fail. Those discourses which serve only to interest for the moment, but have no definite object, soon pall the intellectual appetite; but where there is an end to be attained, as in this case, the "working classes" will come to listen and learn, and will even subsequently enter upon a course of laborious study, in order to render themselves masters of some branch of science. There is another paragraph in this Report deserving of special notice; namely, that relating to the botanical class, conducted by Dr. Hinds, as honorary lecturer. It is as follows:—

"The class for botany has, on the whole, made satisfactory progress during the year, except in the number of members, which has not been so good as is desirable. Two classes of students have availed themselves of this class, namely, *one in whose future prospects and requirements a knowledge of botany is desirable or essential*,* an element, perhaps, in some future examination to which the student looks forward; the other composed of those who study botany for its own sake, and desire to increase their scientific knowledge by a study of some branch of natural history. To the former class the Institute affords opportunities of a valuable kind, not to be obtained on the same terms elsewhere in Birmingham. To the latter class

* The italics are ours.

the Institute holds out equally useful opportunities, in bringing science within the means of the class of artisans and others almost for whose especial benefit and improvement the Institute arose. This class of students in natural and other sciences is far too small, but it is firmly believed that ultimately the number must increase. The existence in some towns, as Manchester, of a large class of artisans and others who take delight and have skill in natural science, especially botany, shows that this branch of natural history is susceptible of being made useful and popular.

"It cannot be said that Birmingham artisans have less capacity than a similar class in other towns, and therefore it is hoped and believed that ultimately this class of persons will gradually be found to acquire tastes of a more elevated and classical kind than at the present time."

Of course Birmingham artisans are not deficient in capacity; but perhaps they may not possess the same facilities for indulging in intellectual tastes as are presented to the humbler classes in other towns. Is there a Field Club in connexion with the botanical class of the Midland Institute, enabling the students to watch Nature in the free exercise of her functions; or are their observations confined to the traces of her handiwork as exhibited in the inanimate objects of the museum?

The scope of this Institution is perhaps the most extensive of any of its kind that has come under our notice. Besides numerous courses of lectures, delivered in some cases by men of the highest scientific attainments, there are classes in geometry, English history and literature, algebra (2), advanced and elementary arithmetic, writing, French, English grammar, composition (2), chemistry (several), botany, experimental physics, and the penny lectures and penny readings, *both of which are better attended than all the rest of the classes together* (excluding that in elementary arithmetic, which is numerously attended). There are also a museum, library, and the other adjuncts to such an establishment. We do not, however, see any mention made of classes in zoology, geology, mineralogy, &c., for which there must be great scope in such an important town as Birmingham.

In striking contrast with the proceedings of the Institution just named, we have those of the "YORKSHIRE PHILOSOPHICAL SOCIETY," whose operations are carried on in the city of York. Favoured with one of the most perfect museums in the world, under the guardianship of seven curators, each superintending his own department of science, with an excellent observatory, under the care of a committee of six gentlemen; and, with every advantage that wealth affords, this society maintains a high position amongst those of Great Britain. The lectures delivered during the last session, as well as the "Communications to the monthly meetings," were various and interesting. Amongst the latter are many of general interest, and one or two extracts from the Report will, we think, please our readers better than any further comments of our own.

A Paper on "ALUMINIUM," by W. PROCTOR, Esq., F.C.S. (read March 5th).

"He traced the history of the discovery of Aluminium from the time of Davy to that of Wöhler and Deville, who first obtained it in any quantity, and described the process adopted by the latter chemist for procuring Aluminium by the decomposition of its chloride by metallic sodium. Certain difficulties attendant on this process led Dr. Percy to suggest the mineral called Cryolite, a fluoride of aluminium and sodium, as a source of aluminium.

The process consists in heating the powdered mineral, with common salt and sodium, for two hours in a covered crucible; at its conclusion the metal is found at the bottom of the slag. The price of the metal, when it was first obtained, was £5 to £6 per ounce. In 1806 Deville had reduced it to £3 per ounce, and it is now usually worth 5s. per ounce, although Mr. Gerhard, who is engaged in preparing the metal from cryolite on a large scale at Battersea, stated at a meeting of the Society of Arts, that he had undertaken a contract at 3s. 9d. per ounce.

"Aluminium is a white metal, with a bluish tinge, and a lustre inferior to that of silver. Its specific grav. is 2·6, or about one fourth that of silver, a property of importance, as this lightness causes a given weight of aluminium to go as far in the manufacture of articles as four times the quantity of silver. It is malleable, and ductile, and possesses considerable tenacity; when pure, it is as hard as silver, but it has no great elasticity, and requires rather a high temperature to fuse it. It is not oxidized by exposure to air, even at high temperatures; it resists the action of sulphur and sulphuretted hydrogen, which so rapidly tarnish silver, and is insoluble in any of the ordinary acids, except the muriatic; potass, soda, and ammonia in solution dissolve it rapidly; and the beautiful frosted appearance seen on articles manufactured of aluminium is produced by plunging them for a short time in a solution of potass at blood-heat, and then immersing them in nitric acid.

"It will easily be seen that a metal possessing the properties above described will be capable of many applications, and aluminium has already been employed in the manufacture of a great number of articles. Its chief use, however, will probably be in the production of alloys, as it gives increased hardness to whatever metal it is used with. An alloy of three parts aluminium and 97 parts iron has the brilliancy of pure silver, and does not tarnish. 100 parts silver and 5 parts aluminium form an alloy as hard as sterling silver, and as easily worked as the pure metal. Copper, with a quarter of its weight of aluminium, gives an alloy of the colour of gold, and very malleable. With 20 per cent. of aluminium the alloy is white; and a mixture of 90 parts copper and 10 parts aluminium is harder than bronze, and has been used for the works of clocks and watches. Calvert describes an alloy of 15 aluminium and 78 iron, which does not rust in moist air or water."

Another paper of deep interest was read, April 2nd, by the Rev. J. Kenrick, on the Rev. Mr. M'Enery's "Researches in Kent's Hole, near Torquay." Bearing, as it does, upon the supposed age of the human race, and expressing the opinions of an enlightened clergyman and antiquary, we recommend it to the careful consideration of our readers:—

"Kent's Hole is a fissure in the limestone rock, which belongs to the Old Red Sandstone formation. Its floor is covered with a stalagmitic deposit, under which lies a bed of mud and gravel, brought in by a flood of water. According to Mr. M'Enery, the various contents of the cave follow each other in this order, proceeding downwards from the surface. First, black pottery, with traces of the lathe, human teeth and bones, beads, bone pins, and other articles belonging to the Romano-British period, when the Romans had an encampment on the down above the cave. Lower down were found arrows and spear-heads of flint, and stone axes, among fossil teeth and bones of herbivorous and carnivorous animals, but no pottery or other works of art; lowest of all the bed of diluvial mud, containing merely animal remains, but no works of art, except some flint instruments adhering to its upper surface. Mr. M'Enery's description of the succession of deposits, however, has been called in question by a geologist of great eminence, Mr. Godwin Austen, who maintains that the human remains and the arrow-heads and knives of flint

occur promiscuously with the bones of the extinct animals in all parts of the cave, and through the entire thickness of the clay; and that no distinction, founded on condition, distribution, or relative position, can be established, whereby the human can be separated from the other relics.

"Mr. M'Enery observed that the flint implements found in the lower deposit were rude, compared with those higher up. This is in accordance with what Mr. Worsaae and other antiquaries have remarked, that what has been called the *stone period* requires to be subdivided, and that there are marks of two stages of advancing civilization, discriminated by the different degrees of skill shown in the manufacture of the implements of flint.

"Mr. M'Enery's researches give a truly formidable view of the strength and ferocity of the carnivorous animals to whom Kent's Cavern served as a den or a sepulchere; such as the *Machairodus latidens*, the *Ursus spelæus*, and the Hyæna. Even the large pachydermata, as the *Elephas primigenius* and *Rhinoceros tichorhinus*, whose bones were found here, must have been dangerous contemporaries to man, armed only with flint implements. Whether they were really contemporaries here is rendered doubtful by the conflicting accounts of Mr. M'Enery and Mr. Austen. Scientific inquirers, however, as Professors Owen and Phillips, have expressed themselves in favour of the opinion that man may have been contemporary with some of the now extinct species of mammalia. This can indeed furnish us with no exact measurement of time, but it seems to carry the history of man further back into past ages than our ordinary chronology allows. Geology has shown, that the progressive changes which the globe has undergone, have been a continued preparation for his residence. He could not want the means of subsistence where the ox and the deer could live, and their bones have been found in the Kent Cavern. It seems in accordance with the wisdom and benevolence of his Creator, that the scene thus prepared for him should not wait long for his introduction."

Most reluctantly do we pass over many other instructive communications to this society, by W. Reed, Esq., F.G.S., on "Fossil Fishes of Monte Bolca;" "The Bovey-Tracy Coal;" "Archæological Papers," by the Rev. J. Kenrick;" and two on the "Decay of Building-Stones," by Dr. Proctor; but we must pass on to other useful institutions.

In DEVONSHIRE an association has just been formed for "the Advancement of Science, Art, and Literature." It is supported by several gentlemen of high position and influence, and its meetings are to be held by turns in the various towns of importance in the county. Exeter was the first rendezvous, and the most interesting feature of the first meeting was the visit of the members of the Bovey-Tracy coal-fields, under the guidance of the well-known Devonshire geologist, Mr. Pengelly.

During the Easter recess a somewhat similar exhibition to the one at Northampton, recorded in our April number, took place at Romsey, in Hampshire. It was called an "Exhibition of the Works of Art and Industry," and was honoured with the presence of the Premier and several other noblemen and ladies. The display was chiefly of a local character, but was enriched by contributions from the collections of the nobility and gentry of the neighbourhood, and from the South Kensington Museum.

NATURALISTS' FIELD CLUBS.

THESE excellent societies are gaining increased vitality, and new ones are springing into existence in every nook and corner of Old England; and, as they are capable of thriving wherever a flower blossoms, or wherever the earth's crust is laid bare to human vision, requiring neither rich patrons, large income, nor magnificent halls of assembly, but only God's pure air and green fields as meeting-places, we have no doubt that each succeeding season will see them multiply in numbers and importance.

At WIGAN, in the midst of smoke and grime, but in the centre also of a rich geological field, such a society has just been formed, and was recently inaugurated with some *éclat*.

The demonstration itself was of an interesting character. Collections of objects of natural history, magnificent microscopes, interesting microscopical objects, aquaria, fern-cases, geological collections; with speeches, singing, instrumental music, and refreshments, were the attractions which ushered into existence what, we have no doubt, will be a successful and agreeable society.

A circular, bearing the signature of several leading men of intelligence, in CLIFTON, was issued in March last, to the inhabitants of Bristol and the neighbourhood, calling upon them to form a Field Club, after the model of those at "Worcester, Malvern, Liverpool, and other large towns," and to "restore to Bristol the prestige it once possessed" for the successful cultivation of natural history. The programme contains every element of success: a low subscription, short excursions, the publication of transactions, &c. &c., and, *we hope*, although it is not mentioned, the admission, nay, every encouragement for the attendance of ladies. We trust the good people of Bristol have responded to the call, and shall now take a run over to TEIGNMOUTH, where there is a small but successful Field Club, which entertained the Archæological Association in 1861. The "proceedings" of this club show that the delightful combes and coves of Devonshire are not neglected by naturalists and geologists; and we find that Mr. Pengelly is an active member of the society, and often imparts a deep interest to its meetings by his instructive addresses on the geology of the district.

The MANCHESTER FIELD-NATURALISTS' SOCIETY continues to flourish, under the active secretaryship of Mr. Grindon; and, to quote the last Report, "the year 1861 has been a period of unbroken prosperity. Everything has gone well, and the prospects for the future are altogether satisfactory."

On the 12th February, the society numbered 430 members, of whom 103 were ladies. Fourteen excursions were made into the surrounding country during the season; and here, as at Liverpool, we find that the ladies are amongst the most successful collectors of plants. Prizes are offered for the best herbaria and cabinets of insects, and photographic views are taken of the places visited.

The soirées, we are told, have been even more successful than the excursions, and the "club" is extending its influence into every circle of society.

The Report says, with great truth,—

"It is not to be expected that the Field-Naturalists' Society, or any similar society, can ever make a great display before the public of what they have accomplished in the shape of work. It is sufficient to find that scientific tastes and philosophical habits of thought are developed, and have had a practical turn given to them, and that members take up different branches of natural history, and apply themselves to sedulous private study, known only to their private friends. This is largely the case in the Field-Naturalists' Society. It is difficult now to go into intelligent company in Manchester, and not find some person who is either a member of the Society, or has attended one of their soirées or excursions as a visitor, and who is glad to acknowledge the pleasure experienced there, and the encouragement he has received to personal inquiry and observation. The amount of latent scientific taste in Manchester is far greater than many would conceive possible, and the Field-Naturalists' function and pleasure is to draw it out and give it direction."

The Liverpool Field Club also continues to extend its numbers and influence. At the close of the season of 1861 it had 630 members, of whom 184 were ladies. At each meeting during the present season many new members have joined. The ladies are the life and soul of this society, and, in order to hold out additional inducements to them to join its excursions, the committee have added to the prizes already granted for the largest number of species collected, another, which is accorded to the lady who gathers and arranges the best bouquet of wild flowers. The "bouquet prize" is an object of great competition amongst the fair ones of Liverpool. We may mention, for the guidance of the directors of other similar societies, that these prizes are well calculated to maintain the interest of the members in the excursions, not so much on account of the value of the books, as the honour which the prizes confer on the successful candidates. The greatest number of species of plants collected during the season was 124, by Mrs. Gibson, and the numbers on other occasions varied from 67 upwards. Miss Rowe, a young lady member of this club, is remarkably successful in these competitions, and possesses very extensive knowledge in systematic botany.

The Holmesdale Natural History Club (Surrey) are publishing a "Flora of the County of Surrey," concerning which we are informed by circular that,—

"The Flora will be arranged on the natural system, and the nomenclature and classification will correspond, as far as practicable, with those of the fifth edition of the 'London Catalogue of British Plants,' on which the manuscripts of Mr. Salmon are based."*

In our last number but one (April), we had occasion to refer to the

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* The publication originates in a collection of plants formed by the late J. D. Salmon, Esq.; and if any of our readers should require copies of the work, they may have them by applying to Mr. J. A. Brewer, Holmesdale House, Reigate. The price to subscribers is 7*s.* 6*d.*

operations of the WARWICKSHIRE NATURALISTS' FIELD CLUB, and since then we have received a report of its proceedings.

These contain a very eloquent address by the president, C. W. Hoskyns, Esq., which our limited space will unfortunately not allow us to transfer to these pages, or we should have transcribed it verbatim, for we are not exaggerating when we say that Mr. Hoskyns' remarks should be read by all who are interested in the successful working of these societies. He referred to the advantages of the study of Nature in her own domains over the perusal of books only; denied the existence of a line of demarcation between the "intellectual" and the "moral;" "terms of our manufacture," as he calls them, and showed how closely they are interlinked with each other. He demonstrated the practical value of scientific research, and instructed the members of the society, over which he presides, how they might best carry out the important objects for which they meet together.

After the president's address, a carefully prepared lecture, on the "Geology of South Northamptonshire," was delivered by the Rev. P. B. Brodie, V.P. Others followed, on various subjects of interest.

On the 27th June, the Warwickshire club visited Malvern, and, fraternizing with the club there, inspected the objects of interest in the neighbourhood; such as the railway tunnels, which present many features of geological interest, the Malvern hills, &c.

In concluding these remarks upon our Field Clubs, we have to recommend more frequent meetings between neighbouring societies, from which much good cannot fail to be derived. A comparison of their respective experiences will be mutually beneficial, and will no doubt frequently lead to the dissemination of scientific truths, the knowledge of which would otherwise have been confined to a few members of one club; and such meetings, too, are conducive to the social and moral welfare of society, inasmuch as they bring into closer relations the most intelligent members of various communities, and remove prejudices and asperities. To those amongst our readers who have been in the habit of regarding science as a dry and laborious pursuit, fit only for bookworms and visionaries, we say, "Join a Naturalists' Field Club, and attend its excursions."

REVIEWS.

PEAKS, PASSES, AND GLACIERS.*

IT may seem rather late now to ask what was the original object of the "Alpine Club," beyond that of meeting in friendly symposium to compare notes and experiences of pleasant long-vacation trips over a dinner-table, and decide what new worlds among the Alps yet remained to conquer. Two series of narratives, nearly fifty in number, written by thirty-nine adventurers in the lofty mountains, have been put before the public, and, as far as the publishers are concerned, it may be presumed not without success. Still the exact object and the result are not clear. How many peaks, before thought inaccessible, have been climbed, and the history of the trip recorded in imperishable type? How many difficult passes have been discovered and crossed? and, perhaps, most of all, how many glaciers, or how many hundreds of miles of glacier, have been traversed that would otherwise have long remained undisturbed except by the rolling of avalanches? All these are points that may be calculated; but, certainly, the literary or scientific fruit is small and unripe. At any rate, the fashion of *doing mountains* is on the increase, and the Alpine Club must have contributed to the growing taste. It is in the hope that the explorations of future adventurers may take a more scientific turn that we give these a place here. Meanwhile they must be dealt with as we find them.

Except an account of a tour in Iceland—a country very little visited by the tourist and not offering much inducement for a visit to any but determined travellers—there is little in the volumes before us that has much of absolute novelty to recommend it.

An interesting notice of a Pyrenean ascent from the Bagnères de Luchon proves that adventure is not entirely confined to the Swiss, French, and Italian Alps, among the European mountains; but as so very large a proportion of the members of the Club seem to decide on attacking that chain again and again, rather than attempt any new field of operations, it must be assumed that there yet remains much to be done there; and, perhaps, we may look forward in time to a considerable library of illustrated stories of Alpine travel.

It is evident that the writers of narratives which in themselves are so much alike that the description tends to become monotonous feel that they must adopt varieties of style to cover a want of variety of matter. Thus,

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* *Peaks, Passes, and Glaciers. Being Excursions by Members of the Alpine Club.* 2nd Series. Edited by EDWARD SHIRLEY KENNEDY, M.A., F.R.G.S., President of the Club. 2 vols., 8vo. London, 1862.

Mr. Ormsby, in giving an idea of his ascent of the Grivola, a somewhat dangerous and difficult mountain, entirely disclaims the smallest object, whether scientific or other, beyond the mere gratification of a whim. In his narrative, also, he exhibits great indifference to the ordinary forms of language; and equal love of, and a familiarity with, slang, both in words and style. As a background or relief to a flat picture this may be a sad necessity; but it is to be hoped that in future volumes the pictures may not require this mode of heightening their effect.

Among the more interesting of the groups of travels in the two volumes before us are those which introduce the mountains of Dauphiné to the reader. But these mountains have all been visited, and the most important facts concerning them have been stated by Professor J. Forbes. Elie de Beaumont, also, has done important work in the district. No doubt there is still much left for the explorer to do, and the district seems well fitted as a scene of trial for the tyro in Alpine work. Another interesting group of mountains recently explored is the group of the Graian Alps and the Mont Iseran, which latter is declared to be a mule-track, and not a mountain.

It is impossible, in the course of a few pages, to give any readable notice of the large number of separate narratives collected in these two volumes. Many of them are uninteresting, and most of them are wanting in telling description. We started at daybreak—we traversed snow and ice, rock and water—we climbed here—we slid down there—we had our luncheon and enjoyed our champagne—our guide did know his way—we ran great risk, but at last we reached the point to which we were bound, and, then—why, then, we got back again, had a good supper, and slept the sleep that the just are reported to enjoy, but that men thoroughly exhausted, whether just or unjust, are almost sure to fall into. Such, with a few details of heights and distances, an occasional correction of what the last describer did and said, a little self-glorification, and much praise of faithful guides, is, in a few words, the sum and substance of all these narratives.

And yet, no doubt, any one such narrative, if read by itself and if written naturally, without a manifest intention to astonish and delight the reader, would be very pleasant and very suggestive, especially to those who have themselves travelled, and have visited more or less of the scenes described. Such an account is that of Mr. Forster, who crossed from the Grütli to the Grimsel, by that most charming of all Swiss valleys, the Valley of Engelberg. We will endeavour to give our readers who have not crossed from the head of the Lake Lucerne to the Uri Alps some idea of what awaits them, if they will undertake the labour and risk incident to this piece of mountain travel. It is a work not beyond the powers of any hardy, healthy man, and will amply repay the exertion.

To Lucerne by rail, and to the "Grütli" or "Meadow" by steamer, is an affair of hours easily measured and easily performed. The Grütli is, in fact, that meadow, dear to the imagination of all Swiss patriots, where the three great founders of Swiss liberty met to swear that they would rescue their native land from foreign thraldrom. It has recently been purchased by subscription and laid out under the auspices of Government. It is

certainly one of the most romantic spots in the wildest and finest part of the lake of the four cantons. Landing, and running up to the Sonnenberg, where is a delightful "pension," Mr. Forster, who started on his journey in bad health, found means, in a few days, so far to recruit that he determined to set out on an expedition, which we will now briefly abstract. The Sonnenberg, by the way, is strongly recommended as an easy and extremely accessible retreat from the great herd of travellers, and, situated as it is on the promontory of high land forming the last of the great recesses of the Lake of Lucerne, the situation is in every respect admirable.

From Sonnenberg to Isenthal is a pleasant walk, and Isenthal is also a pleasant place—small, clean, and not over-civilized or over-frequented. At Isenthal the work begins, and Mr. Forster selected the more difficult of the two routes to the Uri-Rothstock, a very grand peak, which forms a prominent object in most of the views of the Lake of Lucerne. It took six hours from Isenthal, and was rewarded, not only by a grand view of the country, but by the sight of a flock of fourteen chamois, which passed close to the party—a very rare sight, nowadays, under any circumstances, in Switzerland, and one that did not last long. In fact, when the leader of the four-footed party discovered his natural enemy, our author calculates that they went off at the rate of more than twenty miles an hour. The near view from the Uri-Rothstock is preferred by Mr. Forster to that of Titlis,[1] the glacier and *névé* extending to the next peak, the Engelberger Rothstock (*red stick*—the cones are of pinkish limestone). There are, however, no extraordinary difficulties, and Mr. Forster proceeded alone from this point to the valley of Engelberg. The field of snow traversed requires two hours to cross.

There are few more delightful spots in Switzerland than the valley of Engelberg; and at the establishment there, the Hôtel de l'Ange, every reasonable comfort is obtained at most reasonable prices. It is large and well provided, and there is a good road to it from the lower part of the Lake of Lucerne opposite Pilatus. From it, also, numerous excursions may be made, and some of the grandest scenery is very approachable. Titlis raises his head immediately adjacent. The Surenen pass is close at hand, by which, if preferred, either Altdorf or Sonnenberg may be reached. The Joch conducts across to Meyringen; and, for those who are more adventurous, there is a pass on the other side of Titlis across a vast field of ice into the Gadmen Thal. Thence the member of the Alpine Club, disdaining accustomed routes, finds a way across a large, very remarkable, and interesting field of ice—the Trift—pass to the Grimsel.

While on the Surenen Egg, accompanying some friends who were on their way to Altdorf, our adventurer experienced one of those grand, though not very rare, meteorological phenomena—a thunderstorm. The storm passed beneath his feet—rushing up, borne upon the fierce south-west wind at a fearful pace, to meet a mass of rain-cloud coming down from the Weiss-stock. Alone on the mountain ridge, exposed to the pitiless beating of hailstones coming down like rifle-bullets, our traveller wisely waited, under shelter of some stones fallen from the rock above, till the violence of the storm had passed.

From Engelberg across the Joch pass is as beautiful and pleasing a specimen of Alpine work as can be imagined. Too common, and offering too little difficulty to demand a chapter in the volume of Alpine travel, it is better worth the trouble it costs than many greater works. There are the most charming Alpine plants growing out of the snow in the exquisite little Trüb See; there are the steep paths and awkward zigzags of the ascent, and the chalets with milk and cheese—the reward of Alpine labour. But these are but the portals to the path of honour to him who would traverse the Trift. The Stein glacier, at the head of the Gadmen Thal, is the beginning of this pass. From this to the Thierberg, a virgin peak, not much more than 11,000 feet high, but not overlooked, was an easy excursion for Mr. Forster. Afterwards, descending to the valley, the crossing the Trift was another hard day's work, to reach the well-known glacier of the Rhone—one of the noblest and grandest of all those to be seen in Switzerland. Fifteen hours' hard walking across the ice and rock, but chiefly the former, was required to complete the trip; and Mr. Forster relates, with laudable satisfaction, that he was honoured that night above other guests when it was known that he had accomplished the feat of the Trift, and that, to crown all, he had the satisfaction of being pointed out to some curious lady-travellers, in a mysterious whisper, as the hero of the day—"*Das ist der Forster!*"

We have endeavoured rather to give the reader an idea of the style of the better kind of Alpine narratives than to quote mere detail of places and names. We think it somewhat to be regretted that all the devotion of the traveller should be paid to one chain of mountains, though that is no doubt the loftiest European chain; and we should welcome as a novelty an account of a visit to those glorious valleys and mountains of the Carpathians, that have been little examined hitherto; and a notice of an exploration of the Caucasus, of the mountains of Arabia, or of the greater Atlas. All these are "fresh fields and pastures new."

OUR NEW IRONSIDES.*

WAR, in its materials, its instruments, and its results, is absorbing a large share of attention, even from those least interested in its political bearings. It has enlisted in its service our engineers, and men of science, hitherto occupied in more peaceful achievements, and has required of them the solution of some of its most difficult problems. And whilst we wait in the expectation of a time when the need of warfare shall no longer exist, when appeal to arms shall be suppressed in public, as it has already been in private disputes,—whilst we hope that, in the end, each man will "find his own in all men's good," and the mailed fleets and armed towers be broken,—it is yet wisest to learn sadly, from the events of our time, that the ancient scourge of national weakness may not be laid aside; that the last resort in national differences is still the arbitre-

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* *On the Properties of Iron, and its Resistance to Projectiles at High Velocities.* By WILLIAM FAIRBAIRN, Esq., D.C.L., F.R.S.

ment of the sword. And hence we are content to see, in the midst of the peaceful gathering of the works of our industry and our art, the most perfect finish, the most subtle invention, and the utmost resources of our mechanical skill expended on the "works of war."

How to arm our navy to resist the heavy projectiles of modern artillery, and, above all, how to keep out those frightful instruments of destruction, the explosive and molten iron shells, is a problem involving conditions so novel that, during the past year, it has raised more discussion amongst engineers than any other. In the pamphlet before us, Mr. Fairbairn contributes the results of his experience and research, as to the qualities of iron, and the mode of its application best adapted for the protection of ships of war. He long since expressed the opinion that the material, which has almost superseded wood in the mercantile marine, would ultimately prove most suitable for the navy; and this, notwithstanding the adverse results of the partial experiments in 1827, and subsequently. He has lived to see his opinion universally shared, and satisfactorily established in actual warfare, at Kinburn in 1855, and more recently in America. In the new conditions in which we are thus placed, by the improvement of artillery on the one hand, and by the adoption, by other nations, of iron armour for purposes of defence, after satisfactory proof of its superiority to wood,—

"We must look," says Mr. Fairbairn, "to new materials, and an entirely new construction, if we are to retain our superiority as mistress of the seas. There yet remain amongst us those who contend for wooden walls, but they are no longer applicable to the wants of the State; and I am clearly of opinion, that we cannot afford to trifle with so important a branch of the public service as to fall behind any nation, however powerful and efficient they may be, in naval construction."

He adds, that a revolution is in progress in the destiny of the navy, and then continues:—

"It is not for us alone that cyclopean monsters are now issuing from the furnaces of Vulcan; and it behoves all those exposed to such merciless enemies to be upon their guard, and to have their *Warriors*, *Merrimacs*, and *Monitors* ever ready, clothed in mail from stem to stern, to encounter such formidable foes. It has been seen, and every experiment exemplifies the fact, that the iron ship, with its coat of armour, is a totally different construction to the wooden walls which for centuries have been the pride and glory of the country. Three-deckers, like the *Victory* and the *Ville de Paris* of the last century, would not exist an hour against the sea-monsters now coming into use. The days of our wooden walls are therefore gone; and, instead of the gallant bearing of a 100-gun ship, with every inch of canvas set, dashing the spray from her bows, and careering merrily across the ocean, we shall find in its place a black demon, some five or six hundred feet long, with a black funnel and flagstaff, stealing along on her mission of destruction, seen above water sufficiently only to exhibit a row of teeth, one on each side, as formidable as the immense iron carcase floating below. This may, with our present impressions, be considered a perspective of the future navy of England; probably not encouraging, but one on which the security of the country may ultimately have to depend, and to the construction of which the whole power and skill of the nation should be directed."

In reading this description of the unromantic attributes of a modern mail-clad vessel, some of our readers will probably deplore the entire disappearance of the poetry, hitherto associated with the navy, and may perhaps be reminded of Byron's lines:—

"She walks the waters like a thing of life,
And seems to dare the elements to strife.
Who would not brave the battle fire,—the wreck,
To move the monarch of her peopled deck!"

and then turn somewhat deprecatingly to that most graphic account of the *Monitor* as "a Yankee cheese-box on a raft," which is said to give a better idea of her appearance than any of the engravings which have been published. In our own armour-clad vessels, the æsthetic element has not hitherto been sacrificed to so great an extent; but Captain Coles's cupola ships which are in progress will closely accord with the American type.

The questions dealt with in the pamphlet relate to the quality of iron most suitable for armour-plates, and the laws of resistance of such plates to projectiles, as determining the conditions under which they should be applied in naval construction.

Of the three materials, cast iron, wrought iron, and steel, the first is manifestly defective in all the qualities requisite; but the choice between the other two is more difficult. Tenacity, or cohesive force and toughness, or capability of yielding to a blow without fracture, are pointed out as the qualities most desirable. The tenacity of steel is twice as great as that of wrought iron; but Mr. Fairbairn implies that in the trials with ordnance it has proved inferior, even when so soft as to contain only 0·25 per cent. of carbon. If this be the case, our French rivals have made a mistake in clothing *La Gloire* with steel-faced plates.

It is interesting to remark, that chemistry has aided the engineer in this inquiry, the absence of carbon being one of the most available indications of the value of an armour-plate. The data which Mr. Fairbairn quotes show also that the most minute excess in the proportions of sulphur, phosphorus, and silicon, in Dr. Percy's analyses, correspond exactly with deteriorations of strength in his own experiments on the same plates, and with inferiority in resistance to projectiles in the trials at Shoeburyness. The purer the iron, therefore, the greater its value for defence. This result might have been anticipated, but it is none the less interesting to find it clearly demonstrated in independent researches.

In defensive constructions the engineer has to comply with entirely new laws of resistance. Hitherto he has almost universally dealt with slowly-applied forces, which it was convenient to regard as dead (or statical) pressure. But projectiles have a velocity of 1,100 to 2,000 feet per second, and inflict an injury wholly incommensurable with the statical resistance of the plates. Statical forces acting for an indefinite period are regulated by one law; sudden and almost instantaneous impact, by an entirely different one. It is in consequence of a misconception on this point that much of the discrepancy of opinion on the subject of iron armour has arisen. And an adequate return will have been made to engineers for the service they have rendered to naval construction if it

induces them to pay more attention to the dynamic resistance of materials. It will lead to the explanation of many catastrophes (boiler explosions and the fracture of the Hartley Colliery beam, for example) which have been considered almost inexplicable. And war will thus have nourished the arts anew, and yielded fruits of peace.

Mr. Fairbairn shows that the destructive power of the shot depends on its *vis viva*, or the work accumulated in it during the explosion of the powder, and which is known to vary as the product of the weight of the shot and the square of the velocity generated. This product is in turn known to vary as the weight of powder in the charge. The shot is, therefore, merely a carrier of the energy disengaged by the chemical decomposition of the powder. That the destructive power of the shot increases with the square of the velocity explains the inefficiency of the American 200-pounder "Parrot guns," in which only small charges of powder can be expended as compared with the guns employed in the experiments in this country. It also explains the enormous power of the 300-pounder smooth-bore at Shoeburyness when firing a 150-pounder ball with a charge of 50 lb. of powder. Of this last Mr. Fairbairn says :—

"We had just arrived at the desired point of security when the thundering 300-pounder, smooth bore, upset our calculations and levelled the whole fabric with the ground."

The velocity of the 150 lb. shot probably approached 2,000 feet per second.

On the vexed subject of "ships *versus* forts" Mr. Fairbairn sides with Lord Palmerston. He says :—

"A great outcry has been raised about the inutility of forts ; and the Government, in compliance with the general wish, has suspended those at Spithead ; I think improperly so, as the recent experiments clearly demonstrate that no vessel, however well protected by armour-plates, could resist the effects of such powerful artillery" (as the 300-pounder alluded to above).

Whether the doubt, expressed in the last paragraph, as to the possibility of obtaining invulnerability in ships is well founded must be determined by further experiments ; but, looking to the law enunciated by Mr. Fairbairn, that the resistance of plates increases as the square of the thickness, it would appear that at present our means of defence in ships are in advance of the artillery which can be brought to bear against them. The enormous 300-pounder only just penetrated the target representing a section of the *Warrior* and protected by 4½-inch plates, and that, too, after it had been struck by 3,229 lb. weight of metal. But 5 and 5½ inch plates are being employed, which will increase the resisting power by 25 and 50 per cent. respectively, and it is doubtful whether these would be penetrated by even the most powerful modern artillery, at least with the present cast-iron service-shot. In America, 10½-inch plates have been used, but there is, no doubt, a limit to the thickness to which the law of the squares applies. Very thick plates of wrought-iron have been found to break brittle like plates of steel, either from a deterioration in the quality of the material or from the rigidity of a thick mass, causing fracture according to a different law. The entire invulnerability of the

American iron-cased vessels in actual warfare, imperfectly as they are constructed when compared with the *Warrior* or *Black Prince*, is very remarkable. Whilst, on the other hand, the terrible effect of shells on the wooden *Cumberland*, in the battle of Hampton Roads, which, in a short half hour, made her interior look like "a burnt and sacked house" and sent her blazing to her ruin, may teach us that, whether absolute invulnerability is attainable or not, it is a prime necessity of modern warfare, and a guarantee for peace, to provide such security as iron will afford against these new missiles.

A Glossary of Mineralogy. By HENRY WILLIAM BRISTOW, F.G.S. Longman. London. 1862.

MINERALOGY is a science that has few votaries in England, but a certain knowledge of it is indispensable to the chemist and geologist; and to these the book lately published by Mr. Bristow will be found extremely useful, if not indispensable, for reference.

Mr. Bristow does not confine himself to a mere alphabetical descriptive list. In a short introduction he notices the various properties of minerals and the modes of determining them. Like other geologists who have to use this science as an adjunct, he leans to a chemical arrangement, quoting the method followed by Professor Warrington Smyth at the Museum of Economic Geology, which in all essential features resembles that adopted by Professor Ansted in his Elementary Course of Geology and Mineralogy. He introduces a very large number of synonyms; and the accounts of the principal minerals are pithy, definite, and comprehensive. Remarkable specimens in the public museums of England are referred to, and localities are not neglected. The composition is quoted either by chemical symbols or as a distinct analysis.

In the present state of mineralogical science—and it is not likely soon to improve—there is a great advantage in the alphabetical arrangement, as those who have consulted the works of Dana and even of Phillips, in its most approved form, will generally admit; and we doubt not that Mr. Bristow's book will be useful. We would suggest, however, that in a future edition he should give a few more cross references, and bring down his list of localities to accord with recent discoveries. It is rather puzzling to have to think under what heading sulphur, silver, and copper are to be sought, and not easy to see why gold should be described under its own name and the other minerals we have mentioned as *natives*. We miss, too, names so common as *Kaolin*, finding *Pe-tun-tse* and *Kunkur*, which are much less defined varieties. We miss also *Lederolite* (a variety of *Chabasite*); *Marmatite* (a variety of *Blende*), and a few others. These are pointed out rather to show that a careful revision is desirable, than as finding fault with a task which, on the whole, is very well accomplished.

On the various Contrivances by which British and Foreign Orchids are Fertilized by Insects, &c. By CHAS. DARWIN, M.A. (Illustrated.) Murray.

THE perusal of Mr. Darwin's book on "The various Contrivances by which British and Foreign Orchids are fertilized by Insects," might incline the reader to regard it as the result of nothing less than a life devoted exclusively to the subject. Yet of the great discussion concerning the "origin of species," the present work is, in fact, only a single chapter, the details of which have become inconveniently large to be incorporated with the rest of the argument.

The point which the author here seeks to establish is thus stated. "That nature abhors perpetual self-fertilization." "That marriage between near relations is in some way injurious—and that some unknown great good is derived from the union of individuals which have been kept distinct for many generations."

Self-fertilization is a rare event with the Orchids, and the description of the various contrivances by which the pollen of one plant is kept from contact with its own stigma and conveyed to that of another plant of the same species, occupies nearly the whole of the volume.

Orchids, it appears, are favourite plants with honey-loving insects. When the proboscis of a bee or a moth is inserted into the nectary of an orchid, it first comes in contact with a little capsule or pouch, the membrane of which at the slightest touch is ruptured, setting free a liquid and exposing the sticky ends of two club-shaped organs, to the further ends of which the pollen grains are attached. The sticky ends instantly adhere to the proboscis, which, when retracted, carries with it the pollen clubs fastened upon it in a somewhat erect position. Further down the throat of the nectary lies the stigma.

We have then to observe (first), the retired position of the anther chambers, of which there are two, containing the charged ends of the pollen clubs. (Second.) The prominent position of the viscid ends of the pollen-clubs in the throat of the nectary. (Third.) The manner in which the sticky ends of the pollen-clubs are kept moist, till wanted for use, by being immersed in a little pouch of liquid. (Fourth.) The extreme sensitiveness of the lips of this pouch, which open at the slightest touch imaginable. (Fifth.) The rapid setting of the viscid matter, which hardens into a dry cement in a very short time after the sticky ends of the pollen-clubs have touched the proboscis of an insect. (Sixth.) If the attached clubs remained erect, the proboscis at its next insertion into a flower would press the pollen grains into a position similar to that from which they had been taken, namely, into the anther chambers; but no sooner are the clubs fast than their pedicels uniformly begin to curl forward, bringing the pollenized ends of the clubs almost close to the proboscis in a more forward position, so that when the next flower is visited the proboscis pushes the pollenized tips of the clubs past the anther chambers and right upon the stigma of the flower.

In the genus *Catasetum* the flower has two slender horns, which when

touched by an insect convey the excitement of the touch to the anther chambers, which instantly discharge the adhesive pollen-clubs at the head of the intruder. Thus, and thus alone, at least three species of the genus *Catasetum* are fertilized.

Mr. Darwin has manifestly spared no labour in collecting facts illustrative of his subject. He gives a list of twenty-three species of Lepidoptera captured with the pollen-clubs of *O. pyramidalis* attached to their probosces. He has himself made observations on nearly all the British species of orchids, and upon a large number of exotic species, and he arrives at the conclusion that, "throughout the vast Orchidean order—including, according to Lindley, 433 genera, and probably about 6,000 species—the act of fertilization is almost invariably left to insects."

The chapter on the homologies of Orchids is one of the most interesting portions of the book.

At Torquay, Mr. Darwin watched a number of plants of *Spiranthes autumnalis*, and saw them visited by humble-bees. "The bees always alighted at the bottom of the spike, and, crawling spirally up it, sucked one flower after another." "I believe humble-bees generally act thus when visiting a dense spike of flowers, as it is most convenient for them; in the same manner as a woodpecker always climbs up a tree in search of insects." This seems a most insignificant observation; but see the result. In the early morning, when the bee starts on her rounds, let us suppose that she alighted on the summit of a spike, she would surely extract pollinia (pollen-clubs) from the uppermost and last opened flowers, but when visiting the next succeeding flower, of which the labellum in all probability would not as yet have moved from the column, for this is slowly and very gradually effected, the pollen masses would often be brushed off her proboscis and be wasted. But nature suffers no such waste. The bee goes first to the lowest flower, and crawling spirally up the spike, effects nothing on the first which she visits till she reaches the upper flowers, then she withdraws the pollinia; she soon flies to another plant, and alighting on the lowest and oldest flower, into which there will be a wide passage from the greater reflection of the labellum, the pollinia will strike the protuberant stigma. If the stigma of the lowest flower has already been fully fertilized, little or no pollen will be left on its dried surface; but on the next succeeding flower, of which the stigma is viscid, large sheets of pollen will be left. Then, as soon as the bee arrives near the summit of the spike, she will again withdraw fresh pollinia, will fly to the lower flowers on another plant, and fertilize them; and thus as she goes her rounds and adds to her store of honey, she will continually fertilize fresh flowers, and perpetuate the race of our autumnal Spiranthes, which will yield honey to future generations of bees.

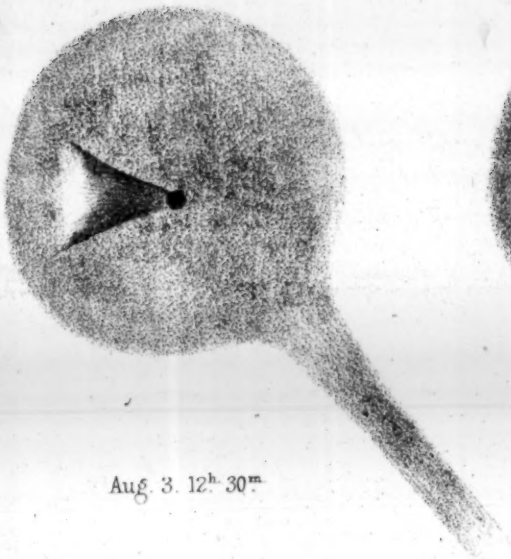
SCIENTIFIC SUMMARY.

QUARTERLY RETROSPECT.

ASTRONOMY.

A SMALL telescopic comet was discovered by Schwabe, at Athens, on July 2, and, a few hours later, at Marseilles, by Mr. Tempel. Subsequent observations and calculations proved that it passed its perihelion on June 22. It continued all along very faint, and was only visible in good telescopes. Its least distance from the sun was about ninety-five millions of miles—almost identical with the earth's mean distance from the central body. We have not seen it noticed that the orbit of this comet bears some resemblance to one discovered at Paris, on September 2, 1698. The direction of motion, the inclination to the ecliptic and the longitudes of the perihelion and node agree pretty well, and the least distance from the sun is not very dissimilar. The comet of 1698 is, however, stated to have been as bright as a star of the second or third magnitude.

A second and much brighter comet was discovered on July 18, at midnight, at the Cambridge (United States) Observatory, in the constellation of Camelopardalus. It was independently detected at Florence, on July 24, and, on the following night, at Rome, by Professor Rosa. On the latter day it is described as being round, with a nebulosity of from three to four minutes in diameter and a distinct nucleus. Although almost circular, it was slightly dilated in the direction of the sun. No tail was visible in the comet-seeker, although with the naked eye one was faintly perceptible. On August 3, when first seen by the writer, the comet was plainly visible to unassisted vision, and a slender tail was distinctly seen in the finder of the telescope. The nucleus was bright, and a well-defined fan-light was seen proceeding from one of the sides, which was almost at angles with the tail. On August 19 the comet had become a very conspicuous object in the Northern hemisphere and the tail could be traced with the naked eye for a distance of eight or ten degrees from the head. The luminous sector had, however, disappeared, and an exceedingly bright jet of cometic matter lay in the contrary direction to the tail. At midnight of August 24, the luminous sector again made its appearance, and a faint envelope was suspected as surrounding that part—a bright jet passed across the fantail from the nucleus, lying almost at right angles to the tail, which latter was as slender as on former occasions, and was separated from the head by an almost dark space. On August 25, at



Aug. 3. 12h. 30m.

Aug. 24. 12h.

Aug. 25. 9h. 30m. p.m.

Aug. 31. 9h. 55m. p.m.

Drawn for the P. S.R. (from nature) by James Breen.

W. West. Lith.

Comet of July and August 1862.

9.30 p.m., the fantail was still faintly visible, but the bright jet of light was now turned in the contrary direction to the tail and appeared like a miniature comet. The aspect of the comet had considerably changed since the preceding evening, and the tail appeared to have become broader and brighter, and to be connected with the head in a more solid manner. No opportunity occurred of viewing the comet before August 31, when a great change was observed to have taken place. The head and tail were now similar in appearance to those of Donati's and the great comet of 1861 —the fantail was brighter than on former occasions: the edges being the most brilliant portions; and the tail was now almost as broad as the head, although considerably fainter. Instead of the appearance of a bulbous root attached to a slight stem, it had assumed the ordinary shape of large comets. It will be seen from the foregoing observations and accompanying plate that the position of the fantail, but more particularly that of the luminous jet within it, was constantly varying. The same phenomenon has been noticed in every great comet observed since the invention of the telescope, although it is only of late years that the matter has been thoroughly investigated. Bessel considered that it was a real oscillation to and fro, dependent on the action of the sun. The observations made by M. Chacornac on the present comet seem, however, to show that no oscillation takes place, and that the jets of light are separate and distinct. Having narrowly watched the different phases (on one occasion for upwards of sixteen hours without interruption), he comes to the conclusion that, as the comet approaches near the sun, the nucleus emits a vaporous jet (something like that of steam) in the direction of the central luminary. This preserves a rectilinear form for some time, showing that considerable force is exerted at the time; but this latter subsequently becomes comparatively weakened, and the jet takes the form of a cornucopia. It finally becomes foggy and diffused, and the active emission appears to have altogether ceased, when another ray and fresh jet make their appearance about thirty degrees from the first, which, passing through all the changes previously undergone by that, finally vanishes away in the lapse of about sixteen hours, whilst the original jet again comes into view. It remains to be seen whether this curious discovery will be verified by the whole series of observations; at all events, it will put observers on the watch to follow more narrowly the changes occurring in those (in every respect) erratic and mysterious objects. It may be added that the path described by this comet bears no resemblance to any previously observed. It passed at its shortest distance from the sun on August 23, when its distance from that luminary was about ninety-two millions of miles. It moved in an orbit inclined sixty-six degrees to the ecliptic, and the head, it was reckoned, was about 100,000 miles in diameter.

Two *well-certified* disappearances of nebulæ have been recorded within the last three months. In both cases the original observations have been of recent date, so that there can be no suspicion of mistake. The first is situate at 3h. 21m. of R.A., and + 30° 54′ of Decl. A few years since it was visible in a two-foot comet-seeker. In 1859, February, it was barely visible in a telescope of three-inch aperture; and, in August of the present year, it was scarcely perceptible in the great Copenhagen refractor.

With a telescope of three-fourths the original size nothing was visible. The second variable nebula is situate at 3h. 38m. of R.A., and + 23° 23′ of Decl. In 1859, October 19, Tempel describes it as large and bright, with a two-foot telescope. In December, 1860, it was scarcely visible in a six-foot telescope ; whilst, at the present time, it is scarcely visible in the largest instruments. It is to Professor D'Arrest that we are indebted for these startling discoveries, which completely alter all our notions in respect to nebulæ. It is very remarkable that the two new variable nebula are situate within nine and eight degrees from the missing nebulæ of last February. The idea of a cosmical cloud, which has been imagined in order to explain other phenomena, will doubtless be reverted to in the present instance. There are very few nebulæ in this region of the heavens, although many clusters and knots of stars. Among others, we have a double nebula, R.A. 3h. 11m., + 40° 43′; a nebula, R.A. 3h. 20m., Dec. + 36° 45′; a nebulous star, R.A. 3h. 59m., Dec. + 30° 20′ ; and a single nebula at R.A. 4h. 19m., Dec. + 34° 54′.

Mars, September 17, 1862, at 11 p.m.
by J. Buckingham, Esq., F.R.A.S.

It will be some years before Mars is seen to such perfection as at the present time. As it will be the only telescopic object among the planets for the next few months, it will of course be duly looked after. It will be the most brilliant object in the heavens during the months of October, November, and December, and will be visible even for the first three or four months of the year 1863. We give a drawing of its appearance on September 17.

A striking instance of the unnoticed changes which are constantly going on in the heavens is the case of the star in Ophiuchus, marked (*b*) in catalogues and maps. Although the variations in brilliancy of this object have been very decided, yet it has not been until the last few months that they have been remarked, and duly inquired into. It has been found that this star fluctuates through all grades of brightness between the 6th and 3½ magnitude. It was reckoned of the former lustre in July, 1849, by Argelander, whilst in June, 1862, it had increased to the latter. The name of Argelander is a sufficient guarantee for the correctness of the first observation, whilst that of the latter can be verified at the present time. Doubtless, the future changes in the brilliancy of this object will be a matter of considerable moment. One has only to compare the faintest of the seven stars in the "Plough" with that which is merely visible to the naked eye, to realize the difference between the two objects.

With the great Foucault reflector of the Paris Observatory, M. Chacornac has been able to resolve the annular nebula of Lyra into separate and distinct stars. He describes the appearance of this well-known object as if looking down a funnel. He verifies the measurement of Sirius and its companion as previously given by him.

The present summer has been fruitful in solar spots of considerable size. In the gallery of "philosophical instruments," at the Exhibition, we notice the photographs of Mr. Titterton, of Ely, bearing upon this subject, and more particularly that of August 4 of the present year, where the spot, lying at the margin of the sun, makes a considerable indentation on that part. Another remarkable spot was seen by Mr. Hodgson, on June 8.

The Saturnian phenomena, observed during the absence of the ring, have been sufficiently curious. Mr. Dawes has made many remarkable observations of Saturn and its satellites and ring, but more particularly an immersion of Titan in the shadow of Saturn, on May 25, and a transit of the shadow of Titan across the disc of Saturn on June 2.

BOTANY.

Araucaria Imbricata.—The destruction of two fine specimens of the Chili pine in the Edinburgh Botanic Garden by the frost of December, 1860, has given Professor Balfour the opportunity of making some observations upon the bark of these trees. Removing the leaves and outer bark, quadrilateral markings appear, varying in form according to their height up the stem, each of them having been connected with a leaf, and more distinctly visible when the external bark separated spontaneously. The appearances thus presented show so close a resemblance to the marks upon the fossil stems, called Sigillariæ and Lepidodendron, usually looked upon as allied to ferns and lycopods, that Professor Balfour thinks the subject has been too hastily decided, and that it should at least be re-considered; very properly insisting, that the fossil botanist who decides upon mutilated ancient plants should at least have a good knowledge of those now covering the globe.

Substitute for Paper.—M. Eugène Simon has recently sent from Japan to the Société d'Acclimatation some young trees the bark of which is used by the Japanese for making paper. These belong to the mulberry subdivision of the bread-fruit tribe, and are closely allied to the tree from which the Chinese manufacture what is termed *crape paper*, and termed Broussonetia papyrifera. The Japanese trees are B. kaminoki, of Van Sieboldt; and this bark, when properly prepared, could be imported for half the price of rags into this country. Moreover, it might easily be acclimatised in various parts of Europe, upon stony, calcareous soils. The branches are cut off every two years, placed for half an hour in hot water, which causes the bark to separate; it is then dried, macerated, and bleached several times, and finally boiled in a lye of ashes; then dried, and pounded into a pulp with water, and the pulp made into sheets.

Substitute for Cotton.—Another important article of consumption which has much failed of late has taxed the ingenuity of inventors to find a

substitute. The cotton-world is on the tip-toe of expectation from the report that a substitute for cotton has been discovered, which has been submitted to the examination of experienced hands, and pronounced, for colour, length, and fineness, all that can be desired. At present, the material which is thus characterized is not divulged, but the inventor or discoverer asserts that it is capable of being produced in any quantity, and at small expense; that is, as low, or lower, than the average price of American cotton.

Lathyrus Tuberosus.—This vetch, common in France, where it is called the *Lorraine truffle*, and which might easily be cultivated in England, is stated, in the "Phytologist," to possess a tuber with a milky saccharine taste, and a whitish fecula, more palatable than the potato, and infinitely more valuable than the batatas, or sweet potato. The flower is handsome, large, red, and pea-shaped; and it is recommended as worthy of acclimatization in this country.

Botanical Expedition to British Columbia.—The committee of the Oregon Botanical Expedition have resolved to send Mr. Robert Brown to Vancouver's Island, on a scientific mission, with directions to explore British Columbia, and the countries adjacent to the Rocky Mountains, and to transmit seeds and roots of plants to the Oregon Association in London.

CHEMISTRY.

PURE CHEMISTRY.—That chemical "will-o'-th'-wisp," *ozone*, has been further investigated by the indefatigable experimenter, Schönbein. He prepares ozone by dissolving pure manganate of potash in oil of vitriol, and introducing into the green solution pure peroxide of barium, when ozone, mixed with common oxygen, makes its appearance, and may be easily detected by the smell and other tests. Amongst other curious and important facts which the Professor has discovered in these researches is one connected with the generation of nitrite of ammonia. This salt, he finds, is always produced when water evaporates in contact with the atmosphere: the mere passage of the water from the liquid to the gaseous state ozonizing some of the atmospheric oxygen, which in its turn converts some of the nitrogen and aqueous vapour into nitrite of ammonia. This may be shown in a variety of ways: for instance, when a piece of clean linen is moistened with distilled water and allowed to dry in the open air, it will be found to contain nitrite of ammonia. This fact is of great interest in connection with the chemistry of vegetation. It has long been debated where and how plants obtain their nitrogen—whether from the soil or from the atmosphere. Schönbein shows that every pore over the whole surface of a plant, by continually evaporating water into the atmosphere, becomes a generator of nitrite of ammonia—preparing part, if not all, of its nitrogenous food; the same thing likewise happening in the ground on which it stands. Schönbein, therefore, inclines to Liebig's opinion—that no plant wants any artificial supply of ammonia, there being enough offered by natural means.

A curious compound of manganese with oxygen—*permanganic acid*—has been investigated by Terreil. The most remarkable fact connected with this body is its volatility. He prepares this acid by distilling, at a moderately low temperature, a solution of permanganate of potash in pure sulphuric acid. Violet vapours are evolved, which condense to a thick liquid of a greenish-black colour and metallic appearance. It is perhaps the most energetic oxidizing agent known: it instantly sets fire to paper and alcohol, the latter with explosion; and, when placed in contact with a fatty body, it detonates suddenly, with emission of a beautiful white light. A very beautiful effect is produced when a few drops of a solution of sulphite of potash are poured upon permanganic acid: a vivid disengagement of light is produced, and a large quantity of acid is carried off in the form of violet vapours, which are reduced in the air and fall down in the shape of brown flocks.

Wanklyn and Carius have prepared a *compound of hydrogen and iron*. By allowing iodide of iron to react on zinc-ethyl, several gases are evolved, and a residue of hydride of iron is left in the tube: it is a black powder resembling metallic iron, and gives off pure hydrogen when gently heated. When dry, it may be kept unchanged; but if moistened with water, it gives off hydrogen and becomes converted into oxide of iron. Hydrochloric acid decomposes it in a similar manner, forming chloride of iron—hydrogen being evolved at once from the acid and the hydride.

Further information on *Thallium*, the new metal, whose existence was first detected by spectrum analysis, has been published by the discoverer, Crookes. It is a heavy metal, bearing a remarkable resemblance to lead in its physical properties. Its specific gravity is about twelve. It has a brilliant metallic lustre, but tarnishes very readily. It is very soft, and may be easily cut with a knife or scratched with the nail; it may also be hammered out and drawn into wire; it fuses below redness, and several pieces may with care be melted together and cast into one lump. The metal is not sensibly volatile below a red heat; its atomic weight is very high. Thallium is readily soluble in nitric acid, and forms well-defined crystalline compounds with oxygen, chlorine, and various acids. The most characteristic property of the new element is, however, the magnificent green colour which it communicates to a flame: this light is perfectly homogeneous and gives a spectrum consisting of only one green line. Thallium, therefore, produces *the simplest spectrum of any known element*. The line appears to be identical in refrangibility with a well-defined line in the barium spectrum. Guided by this delicate test, the discoverer has found that thallium is by no means a sparingly-diffused metal—several pyrites from different parts of the world contain it; and in a paper which the author read before the Royal Society last session he pointed out several sources and localities from which thallium might be obtained by the hundredweight at a time.

Morren has examined the phenomena of *phosphorescence* when the induction spark is passed through rarefied gases. No simple or compound gas singly presents the phenomenon of phosphorescence; but when a mixture of sulphurous acid and atmospheric air is placed in a tube, and the induction spark passed through the rarefied mixture, a splendid and per-

manent phosphorescence is produced. The cause of this is now shown to be the successive decomposition and recomposition of a singular body well known to chemists, the compound which anhydrous sulphuric acid forms with nitrous acid. When in the state of vapour, and very rarefied, the spark separates it into its two constituents, nitrous acid and sulphuric acid, which have only feeble affinities for each other. When the electricity ceases to pass, the elements cannot coexist in the vapourous state without recombining, especially in the presence of oxygen ; and it is during these molecular evolutions that the phosphorescence is kept up.

The action of the voltaic pile upon different substances in the state of igneous fusion has been examined by M. Giradin, in the laboratory of the Duc de Luynes. Passing over the results obtained with salts of potash and soda, which are of no special interest, we may mention the conclusions at which he has arrived in the case of alloys. All alloys, without exception, lose their homogeneousness when traversed by the current. Thus, fused plumbers' solder, when electrolized, becomes brittle at the positive pole, and soft and malleable towards the negative pole. The amalgams and alloys of potassium and sodium can be operated upon when cold. The amalgam of sodium decomposes water when taken at the negative pole, but not at the positive. Potassium and sodium alloy, under the influence of the current, solidifies at both poles. Whatever the electro-chemical rank of a metal, if present in small quantities in the alloy, it goes always to the negative pole. The amalgams of gold and bismuth dissolved in mercury may be taken as examples. Whatever the amalgamated metal, it always returns to the negative pole.

II. Applied Chemistry.—The *manufacture of soda* has lately received a new impetus by the discovery that a very slight additional trouble, in one stage of the operations, will enable a large quantity of the soda to be obtained in the pure caustic state ; besides effecting a great saving in carriage, the product is obtained in a more concentrated and available form. Dr. Pauli has lately shown how this crude caustic soda may be obtained in the perfectly pure state on the large scale. Three tons of it are fused in a cast-iron pot, and the scum which rises to the surface is ladled off; several of the impurities are got rid of in this way. The pot is kept at a dull-red heat all night, and in the morning the mass appears perfectly transparent, the sides and bottom of the vessel being coated with cauliflower-shaped crystals containing all other impurities originally present in the soda. The clear fused liquid is ladled off from these crystals, and, when cold, is ready for use. The caustic soda prepared in this way is hard and brittle, and can be easily obtained in fine powder ; the only impurity which it is likely to contain being a trace of carbonate, it will doubtless prove a valuable reagent in manufacturing, and in chemical laboratories.

The application of chemical knowledge to *the preservation of food* has not received the attention which so important a subject deserves. One of the most ingenious adaptations of this sort is a plan devised by Mr. M'Call, who adopts the old plan of expelling air by boiling, but adds an ingenious contrivance of his own. All who have been condemned to live on preserved meats, are well aware that a little decomposition almost always

takes place in them. This is probably owing to the air never having been completely driven out by the steam in the boiling, or to some making its way again into the cases before they are soldered down. Mr. M'Call effects the absorption of any remaining oxygen by placing in the top of his cans a fused lump of hyposulphite of soda, which, being exposed when the can is soldered, is expected, by the decomposition familiar to chemists, to absorb any oxygen left in the vessel.

Carbolic acid, one of the multitudinous bodies obtained in the destructive distillation of coal, has recently been discovered, by Mr. Ashby, to possess certain properties which will no doubt be applied before long to many useful purposes. It seems to be diametrically opposite to oil in its effect upon rubbing surfaces: just as oil is anti-frictional, so carbolic acid is pro-frictional; or, to state it more definitely, as oil appears to keep moving surfaces asunder by interposing a thin film between them, so carbolic acid appears to make them bite and bind by bringing them into absolute contact. The effect may be at once observed by placing a little of the acid upon a perfectly clean and dry oil-stone, and then rubbing the face of a knife upon it. The sensation of the bite is very curious, and gives the impression of the stone and the steel having absolutely nothing between them, or even as if they were positively brought together by some attractive force. The property of carbolic acid may be advantageously applied to the operations of grinding, filing, boring, and sawing, in metal.

A *harmless green pigment*, fit to be employed in confectionery, has long been a desideratum. The following has been suggested as being perfectly harmless, and capable of replacing the very poisonous arsenite of copper. Thirty-two parts of saffron are infused, for twenty-four hours, in 700 parts of distilled water. Then take 26 parts of carmine of indigo, infused in the same manner in 156 parts of distilled water. Upon mixing the two liquids together, a very beautiful green is obtained, which will colour a hundred times its weight of sugar in a very perfect manner. The colour may be preserved for a long time, either by evaporating the liquid to dryness, or by converting it into a syrup.

An *improvement in silvering glass*, which possesses some advantages over the process known as Liebig's, has been published by Mr. Cimeg. He employs a mixture of ammonia-nitrate of silver and Rochelle salt. This is poured carefully upon the sheet of glass, which has been previously cleaned with a weak solution of Rochelle salt. For a few minutes the mixture begins to get turbid, and after another two minutes, silver deposits on the surface of the glass. In about ten minutes the glass-plate will be covered, and, in about thirty minutes, enough silver (about 30 grains per square yard) will be deposited for most purposes. The mixture is then to be poured off, the silvered plate of glass washed four or five times in water, and then set up to drain and dry. When dry, it must be varnished, when the glass is ready for framing.

The *metal cadmium* has as yet been applied to very few uses. The brilliant yellow colour of its sulphide is largely employed as a pigment, but we can scarcely point to any other practical application of it. It has recently been proposed as an addition to pyrotechnic displays. By

employing a mixture of 20 parts of saltpetre, 5 parts of sulphur, 4 parts of sulphide of cadmium, and 1 part of powdered charcoal, a composition is obtained which gives a white flame surrounded by a magnificent blue margin. Cadmium is now to be obtained tolerably cheap, being prepared as a bi-product in the manufacture of zinc in Belgium.

GEOLOGY AND PALÆONTOLOGY.

ALTHOUGH every one knows that, at a late Geological period, the whole of England was icebound, probably few have realized the vast duration of the glacial epoch. It is still common in the professor's lecture-room to hear the boulder-clay spoken of as "a great splash"; for the idea of cataclysm, beaten back from every other quarter, has at last found a stronghold in the drift. Believing, as we do, that causation has never been more intense in past time than now, it is with interest we notice a little addition to Britain's glacial history, in a paper by Mr. Smith, of Jordan Hill.

In one of the small Western Isles, called Little Cumbra, consisting of *Trap*, there is an old sea terrace or shore, forty feet above the present sea-level, and from it the rock has been worn and removed at least one hundred feet. Now, quite near the shore, and far from this old cliff, are some large boulders, also of Trap, and one of them is split. Split blocks are common in Switzerland, and appear to have become fractured by falling,—generally from the escarpments of ice-terminating glaciers. Hence, as this block is so distant as to preclude the possibility of its having fallen from any neighbouring height, there are no other explanations of its position and breakage than that it either fell from an ice-escarpment at the time the forty-feet terrace was formed, or that it was dropped from an ice-raft drifting therefrom.

These blocks rest on a surface which had previously been smoothed and furrowed by ice, and the glacial striæ, still to be seen, extend down the shore and dip under the sea.* And, therefore, this conclusion becomes evident, that, since the land has had its present level, the total amount of wearing away of the shore has not exceeded a small fraction of an inch, whereas the old glacial period lasted so long that during the time Cumbra was under its influence, hundreds of feet were removed. It must not be forgotten, however, that in the olden time the cliff was buffeted and worn by the more potent agency of ice, while now it is merely lashed by the sea; but, whatever allowance may be made for this difference, the conviction must still remain that, relatively to the great drift period,

> "This fine old world of ours is but a child
> Yet in the go-cart."

An important piece of evidence, tending to show that the drift was no rapid denudation but a slowly-formed deposit, is the occurrence in it of shells which lived at the time. These have been found in various parts of our islands, but few lists are more interesting than one given by the Rev.

* Similar glacial striæ are still to be seen on Snowdon.

W. Lister, in a paper on the drift of Wolverhampton; for it is evident that there lived, in the middle of England, the common Purpura, Winkle, Cockle, and other familiar forms, associated with *Astarte arctica* and shells only found in cold seas.

The way fossil animals died, is sometimes one of their most singular features. Frequently chalk-fish not only preserve their natural shape, but have every fin expanded. Often forests of stone-lilies, four or five feet high, have been overturned, like a wood by a tornado; while in some rocks, both the older and more recent fish occasionally strew a stratum as though an entire shoal had suddenly died. With regard to those specimens which seem to have died rigid, the genius of the late Professor Forbes—noticing a fisherman dip his cup over a boat in the Irish Sea to drink, and finding the star-fishes brought up in the dredge were killed on getting into the stratum of nearly fresh water which floated over the salt sea—conceived that fish, when in pursuit of prey or fleeing from enemies, would sometimes get into this upper layer and, becoming paralyzed, perish in rigid extension. The more general destruction of life is not so well accounted for, though the following fact, related by the Governor of Madras, helps in its explanation :—

"An immense mass of fresh water having been poured into the sea during the season of the south-west monsoon, the fish were thereby killed, and rendered the sea offensive with the smell for some time after. 'The very deep did rot.'"

Probably many of the old local exterminations were due to a like cause.

Ethnologists and antiquaries have long been aware of facts indicating a very recent uplifting of central Scotland. And Mr. Geikie, putting together antiquities, traditions, and geological facts, has endeavoured to show that it has occurred since the occupation of Britain by the Romans. His facts are chiefly these :—Round the coast are old sea-margins, now raised from twenty to twenty-five feet, and, were the land depressed to that amount, the sea overflowing, it would convert into islands a number of low hills having the old Celtic word *inch* (island) incorporated in their names. Then there are traditions that some of these had rings attached to which boats could be moored, and one old man asserted that, when a boy, he saw one of these still hanging to the inland cliff. Moreover, near them, under seven or eight feet of stratified gravel and silt, small rude iron anchors have been found, and, in one instance, an iron boat-hook in no way differing from those now in use. Boats, too, have been found in various places considerably above high-water mark and under several feet of marine deposit. Some of these are the common rude canoe formed by burning out a single tree; but one built with planks showed considerable skill and somewhat resembled a Roman galley; and, singularly, this, found at Glasgow, was associated with the ruder forms, as though belonging to conqueror and conquered.

Further, three skeletons of whales have been found, at a height of twenty-five feet, under stiff clay or silt, and with two of these occurred the remains of deer-horn harpoons, one being eight miles inland. And, besides, an examination of the old Roman walls shows that they were not

built with regard to the present sea level, since, in the case of the Antonine Wall, there is now sufficient space between it and the sea, at the Falkirk end, for a body of men to have marched round unperceived, while, both there and at the Kilpatrick end, the sea would wash up near to it were it twenty-six feet lower.

And finally, the old Roman harbour of Camelon, in the valley of the Carron, is now five miles from the sea. Hence it is thought that the upheaval certainly took place long after metal had come into use; while, from the position and nature and the relics of the Roman occupation, there is no reason why the movement should not have been effected since the first century of our era.

Mr. Smith, of Jordan Hill, however, feels certain there has been no movement of the land in historic times; while Mr. Carruthers has proved that the pottery, supposed to have been Roman, occurring in the raised beach at Leith, is really mediæval, and cannot have a higher antiquity than the year 700, while with it occur tobacco-pipes. He thinks the deposit containing these remains is of late and artificial formation. But Mr. Geikie, having since re-examined the locality, adheres to the conviction that it is a regular stratified deposit of sand and silt.

Many years since, some enormous trifid footprints found in the Wealden strata were referred to gigantic birds. But, it having been ascertained that some quadrupeds, such as the *tapir*, place their hind feet exactly on the spots occupied by the fore feet, so as to obliterate the mark and leave impressions as though the creature had but two legs, a suspicion arose that these large imprints would be more accurately regarded as belonging to one of the huge reptiles entombed in the same rocks. Mr. Alfred Tylor has described one of these markings, from Hastings, which measures two feet from toe to heel, and gives a beautifully-distinct impression of the foot. And, on comparing the proportions of the toe imprints with those of the bones of an iguanodon's foot found some years ago by Mr. Beckles, so perfect is the correspondence that it is impossible to resist the conviction that the marking on the old rippled shore and the foot bones may both be referred to the same creature. Mr. Beckles, too, has since described natural casts of foot-marks from the Wealden of Swanage and the Isle of Wight, nearly three feet and a half long, and so distinct as to show not only the toes but the sloping metatarsal bones. He thinks that other Dinosaurians besides the iguanodon made these tracks.

The iguanodon, as restored at the Crystal Palace, certainly has five toes, though comparative anatomists are now of opinion there are two too many. Several other monsters, quite large enough to have made the markings, coexisted with it, but of their feet nothing is yet known.

It appears that these foot-marks do not all occur on the same level, but at probably as many as four distinct horizons.

The exact age of the sandstone blocks known as Greywethers has long been uncertain, though all observers felt sure that these masses, so interesting from their resemblance to the material of the Druid circle at Stonehenge, belonged to some part of the Eocene strata. Now, Mr. Whitaker finds that the places where they occur are exactly those where, by the London clay thinning away, the Bagshot sands would rest on the

chalk; so that it is scarcely possible to resist the inference that these great masses of grit are connected with and probably derived from that deposit. As, however, a similar sandstone is found at some places in the Woolwich and Reading strata, which underlie the London clay, it is not unlikely that some may also have come from those beds.

The unknowable is ever becoming a more narrow field, and probably the exact thickness of the earth's crust will soon be as well known as our planet's diameter. Not many years since, it was generally fixed at ten or fifteen miles; then Mr. Hopkins demonstrated, on astronomical evidence, that it could not be less than 800 miles; and, now, Professor W. Thompson has pointed out a means by which a more exact measurement may be made. His argument appears to be that the earth is extremely rigid, for were its entire mass of the rigidity of glass it would yield 7–9ths of the extent to which a perfectly-fluid globe of the same density would be influenced by the lunar and solar tide-generating power; and were it as rigid as steel, it would yet yield 2-5ths of that amount. Hence the actual phenomena of tides would, in the former case, be only 2–9ths, and in the latter, but 3–5ths of the amount which a perfectly rigid spheroid of the same dimensions, same figure, and same homogeneous density would exhibit in the same circumstances. And therefore, by carefully observing the amount of the tides at different stations, it will be possible to determine the exact rigidity of the earth, so that, the density being known, it will not be difficult to arrive at a near approximate knowledge of the thickness of the crust. On this evidence, the Professor inclines to think that the fluid part of the earth must be at a depth of from 2,000 to 2,500 miles.

MECHANICAL SCIENCE.

IMPORTANT experiments on marine screw-propulsion have recently been made in H.M.S. *Shannon*. The experiments in the *Rattler* and *Minx*, in 1843–5, led to the adoption of what is now known as the common screw, and which, in spite of some defects, is extensively employed to the present time. It consists of two "blades," broadest at their periphery and tapering to their junction with the propeller shaft. It is defective in this—that the root ends of the blades (nearest the shaft), being twisted nearly perpendicular to the plane of revolution, cause centrifugal action in the water. The power uselessly expended in this way amounts in some cases to 20 per cent. of the whole work of the engines. To remedy this, in the Griffiths screw, one of the best known of numberless attempts at improvement, the blades are fixed on a large spherical boss, about one-third the diameter of the propeller. Thus a sufficient surface is afforded for the attachment of the blades without twisting them into line with the shaft so as to waste power in centrifugal action. The blades are usually three in number, to diminish vibration, and are broadest at their roots, tapering outwards. In the French navy another form prevails, known as the Mangin screw, and consisting of four blades set in pairs parallel to each other, at a short distance apart. The object of the recent experiments in the *Shannon* has been the determination of the merits of these three forms of propeller.

Trials in 1856 gave for the speed of the *Shannon*, with a common screw, 10·49 and 11·69 knots per hour, with 1,057 and 2,216 horses' power respectively. In the recent experiments the common screw was again tried—first with the leading corners of the blades removed, and then with both corners cut away, so as to approximate their form to the blades of the Griffiths screw. The speed reduced in both cases. The Mangin screw gave a higher speed than the common screw, but caused so much vibration as to preclude its adoption in the English navy. As this appeared to arise from the locking of the water between the parallel blades, an ingenious modification was suggested with Mangin blades set at equidistant intervals round a Griffiths boss. Screws of this form, with three, four, and six blades, were tried: the vibration entirely ceased in the two latter cases, and an increase of speed was gained as compared with the original Mangin.

	Speed in Knots.	Horses' Power.
Common screw (one corner cut)	11·29 ...	2,055
„ „ (both corners cut)	11·08 ...	2,094
Mangin (with two pairs of parallel blades) ...	11·33 ...	2,034
Three Mangin blades on boss	11·49 ...	—
Four „ „ „	11·55 ...	2,021
Six „ „ „	11·24 ...	1,947

The experiments with the Griffiths screw have not yet been commenced.

The *Black Prince* attained in her trial trips a speed of 13·584 knots. The *Warrior* reached 14·354. These mail-clad vessels are so similar that the difference is not easily explained. Nevertheless, both are unapproached by any similar vessels in the world, either in speed or power.

The time-honoured process of riveting for structures of wrought-iron is likely to be gradually superseded by a far more perfect process. In riveting, half the strength of the plate is lost in consequence of the metal punched out for the reception of the rivets. Mr. Bertram has contrived a process which, after many difficulties, is coming into use, and has been employed for parts of the mail-clad vessels now building. In this process the edges of the plates are heated by the flame of two portable coke furnaces and welded, so that no strength is lost. Wrought-iron structures thus constructed will be perfectly homogeneous and seamless.

A cannon of aluminium bronze has been manufactured by Mr. Christophe, and presented to the French Government. The alloy is known to possess extraordinary toughness.

The constantly-renewed discussion of boiler explosions has gradually led to a much better appreciation of their causes, and the theory of Mr. Colburn does not leave much to be desired. Corrosion at or near the water line is known frequently to occur to such an extent as to cause rupture at ordinary pressures; and this would afford an easy explanation of many explosions, were it not that the boiler-shell is frequently torn to fragments and the surrounding buildings demolished in a degree more resembling the effects of springing a gunpowder-mine than the escape of steam at common pressures. Hence gradually-accumulated over-pressure has been

a favourite explanation of such catastrophes, and fabulous estimates of the force of the steam indulged in; as, for instance, 1,000 lb. per square inch in the case of the accident on board the *Great Eastern*. Mr. Colburn, however, has shown that there are two stages in the explosion,—first, a rupture at some weakened part of the boiler, and the escape of the contained steam with extreme rapidity, but without violence; next, the generation of a second volume of steam in the highly-heated water suddenly liberated from pressure, which, occurring simultaneously throughout the mass, projects that water upwards so as to strike the boiler-shell with a force proportional, not to the statical pressure of the steam, but to the *vis viva* accumulated in the flying mass. These two stages were accurately observed by an engineer present at the explosion of a locomotive boiler on the North-Western Railway, near Rugby, last year. He noticed the rush of the steam, followed, after an appreciable interval, by the crash of the explosion.

There remain, however, cases in which it is difficult to find any indications of the first rupture assumed by Mr. Colburn. Towards the explanation of these, attention has very recently been recalled to the experiments of Professor Donny, of the University of Ghent. Professor Donny found that if water be completely freed from air its temperature can be raised to 275° Fahr. in the open air without ebullition. On continuing the application of heat, however, the production of vapour is so instantaneous and considerable as to cause an explosion. Now, a large number of boiler explosions are known to occur just as an engine which has been for some time at rest is first started; and long-continued boiling is one method of expelling the air from water. Under such circumstances, it has been urged, a sudden and violent production of steam may ensue, sufficient to determine rupture in boilers known to be safe at their working pressure.

In the French *Monitcur Universel* occurs the following announcement of a new prime mover:—

"The Lenoir motor, of which the principle is the dilatation of air inflamed by electricity, has just realized the hopes we conceived at the time of its first appearance. An engine of six horses' power, with two cylinders, actuates, at the time we write, the presses of the *Monitcur Universel*."

Some experiments have just been made at Shoeburyness on the penetrative power of shells, the results of which reopen the question of the invulnerability of our mail-clad vessels. It has been fully established that ordinary cast-iron shells will not perforate even comparatively thin plates of wrought iron, owing to the readiness with which they break up; in fact, the *vis viva*, instead of being expended on the target, is wasted in demolishing the projectile, and that so rapidly, that the powder is usually scattered without an explosion. Mr. Whitworth, however, has manufactured some shells of cast steel strong enough to resist this tendency to disruption, and the result is, that they prove to have even higher penetrative power than the ordinary cast-iron solid shot. A 12-ponnder shell from a Whitworth gun perforated a 2½ inch, and a 70-pounder

a 4 inch armour-plate. It must be observed that these shells were flat-fronted, a form which has been proved to have peculiar penetrating properties. It may be interesting to note here that the only projectiles which have as yet perforated a target representing the side of the *Warrior*, are the 150 lb. cast-iron shot of the 300-pounder (unrifled) Armstrong, with a charge of 50 lb. of powder; and the 270 lb. solid shot of the Mersey gun, with a charge of 75 lb. of powder.

MICROSCOPY.

Spontaneous Generation.—This old theory, which some have endeavoured to reinstate, has been philosophically and experimentally examined by M. Pasteur, who has satisfactorily demonstrated,—1st. That the air of inhabited places contains a greater relative number of fruitful germs than the air of uninhabited regions. 2nd. That the ordinary air contains only here and there, without any continuity, the condition of the first existence of generations sometimes considered spontaneous. Here there are germs, and there there are none. 3rd. There are few or many, according to the localities. Rain diminishes the number; but, after a succession of fine days, they are more numerous. When the atmosphere has been for a long time quiet, germs are absent, and putrefaction does not take place under ordinary circumstances. From all his experiments, Pasteur concludes that powders suspended in the air are the exclusive origin,—the first and necessary condition of life in infusions, in putrescible bodies, and in liquids capable of undergoing fermentation.

On the other hand, Dr. Wyman, Professor of Anatomy at Harvard College, U.S., has tried the same experiments as M. Pasteur, as he asserts, with very different results. He boiled various organic substances,—cheese, beef, hay, pepper, &c., and excluded the air, or purified it from germs, by heat and other methods of treatment, and yet, after a certain number of days, "Bacteriums," "vibrios," and "other living organisms" presented themselves. Professor Asa Gray witnessed the opening of some of the flasks, and satisfied himself of the presence of infusoria in the contents.

Minuteness of Germs.—Some infusoria are not more than the 24,000th of an inch in diameter; and if we suppose that the ova of infusoria, and the spores of minute fungi, are no more than one-tenth part of the linear dimensions of the parent organism, there must be an incalculable amount of germs no larger than the 240,000th or the 100,000th of an inch in diameter. Since, according to Sullivant and Wormley, vision with the most powerful microscope is limited to objects of about the 80,000th of an inch, we need not be surprised if infusoria and other organisms appear in infusions in far greater numbers than the germs in atmospheric dust, visible by the aid of the microscope, would lead us to expect.

Reproduction of Infusoria.—Dr. Balbiani has published some valuable observations upon these minute organisms, and has satisfactorily proved that they are hermaphrodite, but not self-impregnating.* The reproductive

* "Recherches sur les Phenomènes Sexuels des Infusoires." F. Masson & Fils. (A cheap and interesting pamphlet, beautifully illustrated, which every microscopist should read.—Ed.)

apparatus forms a system distinct in itself, and there is no internal generative cavity. M. Balbiani, notwithstanding their minute size, succeeded in extracting uninjured and subjecting to the action of the surrounding water, some of the young eggs of *Paramecium aurelia* from the parent body, whereupon the egg resolved itself into a vitelline, or yolk, membrane, and a germinal vesicle.

Acari in a Nitrate of Silver Bath.—The extraordinary (supposed) discovery of Mr. Crosse of the generation of acari by electricity has received a curious illustration in the experience of Dr. Maddox, who was astonished to find, in a twenty-ounce nitrate of silver bath, of forty grains to the ounce (for photographic uses), which had been kept for a month in a stoppered bottle, a crowd of little acari, sixty or seventy in number, a little larger than the cheese-mite. That such conditions should be favourable to the development of germs is certainly extraordinary, and contrary to our preconceived notions; yet we have instances sufficient to show that we must not judge of the conditions of the lower classes of animals by those which we find obtain in the case of those higher in the scale.

Migrations of Entozoa.—MM. Pouchet and Verrier have been making experiments upon the metamorphoses of entozoa, and have come to the conclusion of denying the necessary transmission of entozoa as described by most modern zoologists, recurring to the old notion that the cystic (or bladder-like) worms are produced from germs of Tæniæ (tapeworms) which have found their way into places not fitted for them. If the tapeworms of carnivora are due to the cystic worms inhabiting their prey, they ask how it is that sheep, which never devour animal food, sometimes have their intestines so filled with tæniæ as to be absolutely obstructed, as was the case in 1852, during an epidemic in the sheep about Rouen. Again, the number of tapeworms produced often exceeded greatly in number the number of worms given. Thus, in one experiment, one hundred presumed larvæ were given to a young dog, taken from its mother, and carefully isolated. Twenty days afterwards its intestine contained 237 tæniæ, of which the size varied from 4 to 60 millimètres.

Microscopic Writing.—The wonderful machine of Mr. Peters, improved by Mr. Webb, has surprised many, even microscopists, by its results. The real object of this instrument is to produce micrometric lines, which shall serve as tests, being drawn with extraordinary minuteness, and surprising accuracy; the squares traced by the intersecting lines containing a measurement of no greater than the 16-millionth of an inch, but having still sharp and well-defined angles. This is accomplished by a comparatively simple instrument, in which lines or curves traced by a pencil at the extremity of a long lever, are reproduced on glass by a diamond, which, by an arrangement of smaller levers, follows the original tracing, but through an infinitely smaller space. Sentences may thus be written upon glass, which shall be distinctly legible by the aid of the microscope, but yet occupying so small a space that (the number of letters in the Bible being known), it is easily computed that the whole Bible and Testament could be legibly written, on the same scale, twelve times over in the area of a single square inch!

MINERALOGY, METALLURGY, AND MINING.

Mineralogy.—It is curious to observe how often arsenic is found in connection with sulphur and sulphur compounds. The composition of the arsenical sulphur from the solfataras of Naples has been investigated by Mr. T. L. Phipson. This mineral has an orange colour, owing probably to the selenium present. It is only partially soluble in bisulphide of carbon, which dissolves completely the crystallized sulphur of Sicily. It is found, on analysis, to contain 11 per cent. of arsenic, and $\frac{1}{4}$ per cent. of selenium. The arsenic is doubtless present as tersulphide. Arsenic is frequently found in iron pyrites (bisulphide of iron); and as sulphuric acid is now prepared in large quantities from that mineral, the arsenic is carried on, and contaminates the acid. The mineral fahlerz, or tetrahedrite, which is mainly a sulphide of copper, frequently contains a large per-centage of arsenic.

The isle of Elba appears to be an inexhaustible source of remarkable minerals. Some months ago crystals of garnet were found there, having a very peculiar form. They have recently been described by M. Luigi Bombicci and M. F. Pisani. Garnet crystals in general vary but little in form, the predominating faces being those of the rhombic dodecahedron and of the trapezohedron. In the crystals under consideration, however, the predominating form is the regular octahedron—the same which is so prominent in artificial crystals of alum. The octahedral garnet of Elba is found in serpentine rock, and is nearly always accompanied by chlorite and yellowish epidote. It has the colour of honey; and the new method of spectrum analysis shows lime to be an important element.

An analysis of some clays from the coast of Almeria, Spain, has been made by M. Terreil. They are suitable for porcelain. It is remarkable that they taste of chloride of potassium, although, from their proximity to the sea, one would expect the taste of chloride of sodium to be prominent. Along with them is found a red clay, which, from containing much more alumina and less silica than ordinary clay, possesses refractory properties in the highest degree. Hence it is suitable for furnaces—a very important point at the present time, when metallurgists have a difficulty in finding clays sufficiently fire-proof. Steatite has very recently been proposed as a substitute for fire-clay.

Mica is coming into use in Paris for preserving, silvering, and gilding decorations in churches and public buildings. After being cut to the required thickness, it is coated with isinglass, and the gold or other substances added. It is allowed to dry, and then glued or otherwise cemented to the object to be decorated. A burnisher of agate is used to make it smooth.

Turning to *metals*, we find an announcement that Professor Chandler has discovered a new metal in the native platinum of the Rogue River, Oregon. So far, only very minute quantities have been obtained, and further particulars are required. The discoverer believes it to be probably identical with the one discovered in 1852 by Dr. Genth among grains of platinum from California.

Mr. Phipson, in a letter to M. Elie de Beaumont, draws attention to a specimen of native zinc now in the International Exhibition. The specimen occurs in basalt from Brunswick, near Melbourne, Victoria. It has before been stated by G. Ulrich that metallic zinc has been found near Victoria; and, according to Becker, it occurs also in the gold-washings of the Mitta River.—(H. W. Bristow.) Such cases are remarkable, it being very uncommon to find any readily-oxidized metal in the native state.

The mineral lepidolite, or lithiamica, has been used as a source of lithia. Certain varieties contain more than 1 per cent. of the newly-discovered metal rubidium, and these form a convenient source for obtaining this element and its compounds.

Welsh gold continues to attract increased attention. It is constantly being discovered in fresh localities of the Dolgelly district, and expectation is raised to a very high pitch about the auriferous region. It is variously found in quartz, in lead, in alluvium, and in blende. Since the beginning of 1861, about 7,000 oz. have been extracted from quartz-rock in the district. The value of the precious metal thus obtained is more than £25,000, at a cost of £2,000, exclusive of the royalty of one-twelfth paid to the Crown. At Clogau, lately, no less than 142 oz. were obtained from 840 lbs. of quartz. Later accounts state that the district is now being examined by Mr. Mosheimer, commissioner from California to the International Exhibition. He pronounces the district very favourable, but condemns the mode of extraction used at Clogau. It is said he is so confident of the value of some lodes, that he has purchased large interests, sanguine of being well repaid. Explorers have now found their way to the isle of Anglesea, where there is much quartz that resembles that of the gold-bearing districts.

Metallurgy.—The preparation of cast-steel is attracting very considerable attention. Bessemer's process and modifications of it are fast gaining ground. It has frequently been objected to this process that it did not sufficiently or even sensibly remove the sulphur and phosphorus from the cast-iron. Mr. G. Parry, of the Ebbw Vale Iron Works, Monmouth, has patented certain improvements in the manufacture of iron and steel, one object of which is to get rid of these objectionable constituents. He takes ordinary wrought-iron and raises it to a very high temperature in a melting-furnace along with fuel and fluxes. The heat obtained is much greater than that required to melt the iron, which combines with some of the fuel, and becomes carbonized. By subsequent puddling, much of the sulphur and phosphorus are got rid of along with the carbon. If necessary, the carbonization and puddling are repeated. He thus obtains purified wrought-iron. This may be carbonized in the same manner sufficiently to convert it into hard steel. And from this soft steel is obtained, by re-melting it in a separate furnace, and blowing air through it. By these processes nearly all the pig-iron produced in this country becomes available for the manufacture of cast-steel.

An important memoir on this subject by M. Frémy, well known from his researches on the composition of steel, has been lately read before the French Academy of Sciences. He remarks that steel is growing in importance so rapidly that it is incumbent on any nation wishing to preserve

its position, to keep up with the metallurgical science of the day. In employing methods requiring much fuel, France could not successfully compete with England, and his object has been to discover processes which will place his own nation in a more advantageous position. It was formerly considered that the ores of Sweden and Russia were the only ones suitable for making iron destined to be converted into steel; and it was also believed that the iron must obtain from its ore a sort of *propensity* for steel. M. Frémy tried to find out from what this propensity resulted, and his analyses led him to believe that iron required not only carbon, but other metalloids, as phosphorus and nitrogen, in order to become steel. [These conclusions were at the time hotly contested in the Academy.] He came to England on the jury of the Exhibition, and saw Bessemer's process, which left doubts on his mind whether it could be applied to the comparatively impure French iron; but his experiments, conducted on an extensive scale, completely reassured him. It resulted that any iron, if sufficiently refined, could be converted into excellent steel by the necessary processes. He was able in twenty-five minutes to convert French cast-iron, worth about ten francs the 100 kilogrammes, into cast-steel worth 150 francs the 100 kilogrammes. He is careful to say that in every case chemical examination of the iron is necessary in order to find out what constituents require removing, and what require adding.

It is now known that Bessemer is making steel from a hematite pig-iron of the North, infinitely superior to anything ever produced on the old converting principle from the most expensive kinds of Swedish iron. Hence, as a trade circular remarks, "there is great demand for hematite pigs."

There is a belief among practical men in Germany that pig-iron which contains copper cannot be puddled; and it has been said that when one puddler wishes to annoy another, he will sometimes throw into the iron a bit of copper, such as a small coin, and that this prevents the iron from "rising." Dr. List, of America, has observed two instances which go to prove that this belief may possibly be correct. In one of these, where the puddling did not succeed, he found about 0·3 per cent. of copper.

The far-famed swords of Damascus were examples of the wonderful perfection to which the manufacture of steel could be brought, even in a long-forgotten age. The art of manufacturing them was lost for centuries. Besides their elasticity they were valued for the peculiar mixture of light and dark waves on their surface; and it was long found impossible to imitate this appearance. At present, however, blades resembling the old Damascus scimitars, equalling them in temper and elasticity, are made at Solingen, in Germany, the only establishment of the kind in the world. A faggot is first formed of alternate fine bars or wires of iron and steel. It is drawn out, doubled, and twisted several times, and then formed into a ribbon. Two such forged ribbons are welded together, enclosing between them a thin blade of the best cutting English steel. After polishing, the Solingen Damascus blade is dipped for a short time into dilute sulphuric acid, which, by rendering visible the carbon of the steel, produces the wavy surface so much desired. The combined twisted iron and steel gives peculiar toughness to the weapon.

M. Alf. Riche, in studying the difficult subject of metallic alloys, has

made use of a new method for indicating the point when a true chemical compound is obtained. He examines various mixtures of two metals, comparing their densities with that which would be expected were no combination to take place. In most cases it is found that there is a contraction; and the point of *maximum* contraction he considers to indicate the existence of a true alloy. By this method he determined the composition of the alloy of tin and lead to be the same as was obtained by Rudberg in a totally different manner.

Mining.—The lamentable accident at Hartley Colliery, in January last, gave rise to a general belief that two shafts are required to each mine for the purposes of ingress or egress. As a result of the outcry, an Act has been passed which compels colliery proprietors to have two separate means of exit from each mine, although the two openings need not belong to the same mine. Fortunately many other dangers are lessened by the use of two shafts, so that the compulsion cannot be considered a hardship.

Many accidents have happened in coal-mine shafts from the breaking of the rope. A great variety of "safety-cages" have been invented, so arranged that if the rope breaks, a set of springs push out arms or levers which grip or wedge fast against the conducting-rods, so that the cage is brought to a stand. One difficulty, however, has arisen from the employment—now becoming very general—of iron conducting-rods, whilst most "safety-cages" were suited for wooden ones. Two or three modifications have, however, lately been brought out, which are intended especially to apply to iron rods, and we hope that they will receive all attention from the colliery proprietors.

PHOTOGRAPHY.

A TRIUMPH OF PHOTOGRAPHIC ART.

PERHAPS some of our readers may think that a record of the various improvements which are made from time to time in the photographic processes would derive additional interest from a description of the results obtained by new applications to the art. Such an account would, however, fill our pages, and leave room for no other subject; for in the present day, everybody and everything is photographed. Objects which require the highest powers of the telescope or microscope for their definition are brought before our eyes in a clear and agreeable picture. Others, again, are reduced from their natural size, and the photographic image is so diminished that the microscope must be employed to render it once more visible to the eye. Some of these works of art are simply curious and interesting; others are also useful. Then, as to persons, we will not ask who *is*, but who is *not*, photographed nowadays? Indeed, we think, it will be obvious to all, that it would be impossible for us to give an account of the various results which are from time to time attained by means of photography. Nevertheless, when extraordinary instances of success are brought under our notice, such as we deem deserving of the attention of our readers, we shall at all times be glad to accord them a portion of our space.

Of these, a striking one is now before us, and it is rendered doubly interesting from its immediate connexion with the general progress of every branch of science. It is a photographic picture of twenty-two gentlemen, leading members of the British Association, who met in Manchester last year, and who are artistically grouped (mostly seated), in the drawing-room of the President, Dr. William Fairbairn.

Some of the gentlemen are personally known to us, and, judging from the speaking likenesses of these, we have no doubt that all are equally perfect. There is a total absence of all stiffness or awkwardness either in the attitudes of the individuals, or in the whole or any portion of the group. One or two appear to be speaking, the rest listening attentively, and, quite contrary to photographic precedents, all appear smiling and good humoured. What renders this still more extraordinary is, that each of the portraits was taken separately, and the picture afterwards compiled by the artist, Mr. Alfred Brothers, of Manchester.

The copy before us is reduced from the original, and is 16 inches by 9 in measurement. The original is 2 feet 9 inches by 1 foot 7½, and its production involved no less than 40 separate printings! The gentlemen thus vividly portrayed are:—J. F. Bateman, Esq., C.E.; Sir R. Murchison, F.R.S.; C. C. Babbington, Esq.; Rev. W. V. Harcourt; Rev. Dr. T. R. Robinson; R. B. Darbyshire, Esq.; Sir David Brewster, K.H., F.R.S.; Alderman Neild; Professor Airy; Lord Wrottesley, F.R.S., &c.; General Sabine; Joseph Heron, Esq.; Professor Miller; M. Curtis, Esq. (Mayor); Alderman Mackie; Wm. Newmarch, Esq.; Professors Hopkins, Sedgwick, Willis, Phillips, John Crawfurd, Esq., and the President, Dr. Fairbairn.

The price of the picture is a guinea, which is about the value of any one of the portraits, for those who take an interest in the persons photographed. The London publishers are Day and Son; Manchester, A. Brothers.

One of the most conspicuous and, at the same time, important results which has made itself apparent, in connection with the display of photographs in the International Exhibition, has reference to the degree of permanence attainable in these works of art, and to the dependence which may be placed upon the photographic system of record. It is an undoubted fact, that a large number of the pictures on view at the Exhibition are becoming rapidly defaced, and are showing the most unequivocal signs of fading; some of these which have suffered most have contracted a uniform yellow complexion; others, at an earlier stage, are fading in patches, and present a kind of mottled aspect; some few of the worst cases have, we understand, been altogether withdrawn by their owners from public inspection. These appearances are by no means limited to the works of one or two operators, nor to the productions of England alone; for the same indications of fading are apparent in the beautiful specimens of photography distributed throughout many of the foreign courts. Numerous instances are observable in which, among several impressions mounted together in the same frame, and subject therefore to the

same influences, a few only have succumbed to the trying conditions by which they are surrounded, the rest remaining apparently uninjured.

In searching for the primary causes which are likely to be operating adversely in all these instances, it is not necessary to look far to discover the evidence of a damp atmosphere, and considerable fluctuations in temperature, as being paramount among the causes that have occasioned so much destruction. The glass-plate in front of the pictures is frequently bedimmed with a film of dew, and the mounting cards are, like the photographs, manifestly affected by damp, several of them having become spotted with mildew; this is especially the case with the show-frames of the London School of Photography, and those of Mr. Warner, of Ross. The beautiful view of Buttermere, exhibited by Mr. James Mudd, and hanging beside the former on the same wall, is also the victim of circumstances which are plainly indicated by the growth of mildew on the mounting-card; while, strange to say, an excellent print of the South Stack Lighthouse, by the same artist, and placed contiguous, has resisted perfectly the action of moisture. The other works by Mr. Mudd are hanging chiefly on the central screen in the photographic gallery, where they are considerably less liable to be affected by damp, and have consequently preserved all the delicacy and beauty of toning for which the photographs by this gentleman have long been celebrated.

The same remark applies to the pictures exhibited by Mr. Vernon Heath; to the views in North Wales, by Mr. Henry White, and by Mr. Sidebotham; to those of Mr. D. Campbell, of Ayr; and likewise to the exquisite landscapes in Madeira, by Mr. R. M. Gordon: none of these disclose the least symptom of fading, and all are placed upon the central screens. In like manner, with regard to the portraits by Mr. T. R. Williams, and to the magnificent series of abbeys and cathedrals by Mr. Francis Bedford, not one of these shows the least indication of fading; but it must be stated that they occupy the more favoured position in the centre of the gallery.

A remarkable instance of the formation of mildew is apparent on the leather binding of a book exhibited by Mr. A. W. Bennett, and entitled "The Ruined Abbeys and Castles of Great Britain, illustrated by Photography." This book is inclosed within a glass case, and hangs directly in contact with the wall. Some few of the exhibitors appear, however, to have adopted the suggestion of Mr. G. Wharton Simpson, and have inserted pieces of cork between their frames and the objectionable wall; the advantage gained by this precaution is already manifest by the protection afforded to these prints.

As the general conclusion, from observations made upon the photographs now on view at the International Exhibition, it must be admitted, that the security of a photographic record depends, not merely upon the amount of care bestowed originally upon its preparation, but quite as much upon its being preserved in such a manner as to exclude, as far as possible, the adverse influences of damp, or actual contact with moisture, produced by condensation on the front glass: conditions to be fulfilled which, as yet, do not appear to have received their merited share of attention.

The quantitative question, in reference to the amounts of silver and gold necessarily expended in the operation of photographic printing, has received some further elucidation, by experiments lately made in this direction by Mr. John Spiller, assistant chemist to the War Department, at Greenwich. The practical conclusions established by this gentleman's analytical results are to the effect, that upwards of eighty per cent. of the silver originally employed in the process of sensitizing the paper may be recovered in the state of precipitated chloride and sulphide, by judiciously collecting the various washings and waste solutions, and treating them with common salt; or, in the case of the fixing baths, and other solutions containing hyposulphides, with crude sulphide of potassium. These products being separately reduced to metal, are stated to yield in the aggregate the large amount of silver indicated, from which the pure nitrate may be again prepared, and, at the same time, a certain proportion of gold rescued for further employment in the toning process. By adopting the suggestions of the author, it appears that of the fifty grains of nitrate of silver ordinarily taken up by the full-sized sheet of albumenized paper, at least forty grains are recoverable, and that, at the rate of four shillings per ounce troy, one pennyworth of silver need only be actually expended in the production of a single proof of the largest possible size (seventeen by twenty-two inches).

The most striking improvement in construction which we feel called upon to notice is one referring to the camera. In the ordinary form of the double-bodied instrument, it has hitherto been customary to make the hinder portion slide within the front case, to meet the adjustment for focus; but, by reversing this arrangement (which is now becoming a general practice), the lens and smaller front part of the camera are made to travel forwards by the action of an endless screw in the base board, the ground glass remaining stationary, by which means the operation of focusing is more readily accomplished than when, on the old plan, the image is constantly approaching or receding from the eye. Another advantage gained by this arrangement is, the increased accommodation provided for the reception of the plate-holder at the back of the camera, and the possibility of taking therein pictures of somewhat larger dimensions, on account of the interior form of the instrument humouring, instead of being opposed to, the direction taken by the rays of light diverging from the lens. The large camera, made on this principle by Mr. Dallmeyer, and shown in the nave of the International Exhibition, is one among many illustrations of this novelty in construction.

PHYSICS: LIGHT, HEAT, AND ELECTRICITY.

A PAPER, by A. J. Angström, has been communicated to the Editor of the *Philosophical Magazine*, "On the Fraunhofer's-lines visible in the Solar Spectrum." He repeats the statement, "that a body in a state of glowing heat emits just the same kinds of light and heat which it absorbs under the same circumstances;" and considers that "the electric spectrum must be viewed as the superposition of two spectra—

the one belonging to the metal or conductor of which the electrodes are made; and the other, to the gas through which the spark passes." The object of his present investigation was to make a new examination and accurate drawings of the solar spectrum; to determine the wave-lengths of many of its lines, and also of the lines in the spectra of different metals. He has confirmed the statement of Kirchoff—that the atmosphere of the sun contains iron, magnesium, nickel, and chromium; the lines due to iron "are the most characteristic in the whole spectrum." He adds, as a result of this last research, that calcium, aluminium, and manganese exist in the sun; and also, in all probability, strontium and barium; and concludes by some remarks on "Fluorescence."

Mr. J. Attfield has examined, by the aid of prismatic analysis, various flames containing carbon, and has found that ignited oxy-carbons, hydro-carbons, sulpho-carbons, and nitro-carbons emit certain rays of light in common; and concludes that these rays emanate from ignited carbon vapour. When observed by the unassisted eye, the prevailing colour of ignited carbon is light blue. By special manipulation, he has obtained the carbon spectrum with carbonic oxide, olefiant gas, bi-sulphide of carbon, and cyanogen.

M. Jaunsen, in a note communicated to the French Academy of Sciences, affirms that he has recently been able to determine the presence in the solar spectrum of permanent rays which ought undoubtedly to be attributed to the action of the terrestrial atmosphere, and has constructed a spectroscope by which he has been enabled to examine these rays or bands, moment by moment, from sunrise to sunset, and has found them to vary in intensity with the height or thickness of the atmosphere through which the sun's light has to pass.

Some time ago, Gladstone examined the nature of light which had passed through dilute solutions of nitrate of didymium, and discovered two dark lines in it by spectrum analysis; and Professor Rood, of America, has lately repeated the experiments with a strong solution of considerable thickness of the same substance. He has found that when sunlight or lamplight is transmitted through a thickness of twelve inches of this strong solution, and analyzed by Kirchoff's spectroscope, the spectrum is seen crossed by twelve distinct lines, some of which are very broad and others very fine. D, or the sodium line, is just cut off by one of these, and from this results the singular phenomenon that a sodium flame is invisible through a foot thickness of this liquid, although the liquid is nearly colourless and scarcely at all alters the tint of ordinary white objects viewed through it.

In our last number, we stated that a French commission had examined and commended M. Serrin's newly-invented regulator for electric lights; since then, M. Serrin has exhibited his electric lamp at the Polytechnic Institution, London, and all agree in stating that the light emitted was perfectly steady and uniform in intensity—a result which has never heretofore been perfectly obtained with an electric lamp, and which was in the highest degree desirable. The following are some particulars of the structure and action of the lamp from a published description of it by M. Serrin; and those who are acquainted with the mechanism of such

lamps will at once perceive that it does not differ from them in many respects. The two carbon electrodes are vertical, the upper or positive one being fixed; the lower one is attached to the armature of an electro-magnet, and is capable of moving up and down vertically within a space of about one-tenth or one-eighth of an inch; it is supported at the required height by two springs, which are capable of adjustment by means of a screw, and is drawn downwards by the attractive force of the magnet upon the armature when it approaches too near the upper electrode; it requires a weight varying from 150 to 460 grains to depress the armature, according to the degree of tension imparted by the screw to the second spring. The apparatus is very solid and durable.

The development of the marvellous power of the electric induction coil is still progressing, and it is impossible at present to say how much further it will proceed. It began but a few years ago to excite attention, when sparks half an inch in length were obtained by Rhumkorff, in his admirable apparatus, by means of superior insulation and greater length of wire; from that time many investigators have been engaged in extending its power: Mr. Hearder, of Plymouth; Dr. Callan, of Maynooth; Messrs. Bentley and Ladd, of London, and others, gradually increased its power of giving sparks to a distance of about five or six inches; and Mr. Ritchie, of Boston, United States, in a large coil which he made for Mr. Gassiott, of London, by winding the enormous quantity of fifty miles of fine wire on his coil in a peculiar manner, obtained sparks about twelve or fourteen inches long; and even this length of spark has been considerably exceeded by Rhumkorff, who has obtained sparks nineteen inches long. Recently, however, at the last *conversazione* of the Royal Society of London, a very remarkable coil was exhibited by Mr. Siemens, and excited great admiration, which has altogether surpassed previous attainments in this direction. First, we will take the effects said to have been obtained by it, and then briefly describe its construction and peculiarities. On the evening in question, with two elements or cells of Bunsen's battery connected with the primary coil, the two wires of the primary coil being connected parallel, sparks were obtained twelve inches in length, and, with six elements, they were thirteen inches and a half long; but, by connecting the two primary wires as one continuous wire, the sparks were increased in length to nineteen inches; the electricity then escaped in brilliant flashes of light through the air from many parts of the coil. On the above occasion, the coil was not worked to its full power, in consequence of the batteries being hurriedly prepared, and therefore did not give the maximum length of sparks. On a previous occasion, the following effects were stated to have been obtained:—A single Bunsen's element gave sparks 8·4 inches long; two elements, 15·6 inches; three ditto, 19 inches; four ditto, 20·4 inches; five ditto, 22 inches; and six ditto, 23·2 inches.

In all cases with this coil, the mechanism for making and breaking contact is worked by a separate battery consisting of Daniell's elements, and the contact at the break is made by a platinum point, dipping into a vessel containing mercury amalgam covered with spirits of wine. The plates of the Bunsen's battery for exciting the coil were about ten inches wide. The iron core of the coil is 37·4 inches long, and 2·36 inches diameter, and

consists of varnished straight iron wires 0·05 inch diameter. The outer diameter of the coil is about 8 inches. The primary coil consists of two parallel insulated copper wires 0·1 inch thick, and may be connected either as one wire of the total length, or as a double wire of half the length. The primary coil is surrounded by a cylinder of ebonite, which is thicker at its ends than at its middle, to resist the greater tension of the electricity at those parts. The secondary coil consists of 11,762 yards, or 6·88 statute miles, of insulated copper wire, of 0·006 inch diameter, and is wound upon the ebonite cylinder in 299,198 turns; its total weight is 64 pounds. The great power of the coil depends largely upon the arrangement of the secondary wire, which is as follows:—The space outside the ebonite cylinder is divided into 150 narrow and deep grooves, by means of thin, flat, annular discs of ebonite, which fit closely upon the cylinder; the fine wire was wound into each of these adjacent spaces alternately in opposite directions, until they were all filled, connecting each section of wire at the bottom of the groove with its neighbouring section on one side, and at the top of the groove with its other neighbouring section on the other side, and so on throughout the entire series, so as to form one continuous wire. This separation of the secondary coil into numerous sections by a powerfully insulating material greatly increases the resisting power of the insulation; the plan also of winding each alternate section in opposite directions is also of great value in a similar aspect. The condenser consists of several discs of paper glued together, and covered with tin-foil, the surface of the two tin-foil coatings being equal to sixteen square feet each; the condenser of this apparatus does not much affect the length of the spark, but is important to prevent the mercury of the break contact from being violently thrown about. Owing to the peculiar construction of this coil, greater effects are obtained with seven miles of secondary wire than had been previously obtained, in some other coils, with fifty miles; the leading principle of its construction appears to have been, to proportion the amount of resistance to the amount of tension in all its parts.

Mr. Siemens also exhibited a new telegraphic instrument remarkable for rapid transmission of messages through long circuits: it is worked by means of magneto-electric currents, and each signal requires two currents, one positive and one negative, to produce it; the code of signals is that known as "Morse's alphabet." Eighty words per minute were transmitted through a resistance equal to 3,000 statute miles of underground wire. It is said that a speed of 400 letters per minute may be accomplished, day and night continuously, by means of this instrument.

M. Becquerell has exhibited to the French Academy of Sciences specimens of metals obtained by electrolysis, accompanied by a memoir describing the methods he adopted to obtain fine specimens of cobalt, nickel, silver, gold, and platinum. The plan he adopts is to decompose concentrated solutions of the respective metals by currents of very feeble intensity, thus avoiding tumultuous deposits, and enabling the molecules to group themselves regularly and firmly; the intensity of the currents he employs varies with the density of the respective solutions.

Mr. Gore has described, in the Proceedings of the Royal Society, "two additional kinds of electro-deposited antimony possessing the property of

evolving heat: one of them is obtained from a solution of bromide, and the other from a solution of iodide of antimony," and has given "additional information respecting the peculiar heating-antimony obtained from the aqueous terchloride." The manifestation of heat is greatest with the one from the chloride solution, and least with that from the iodide. An explanation is also suggested of the mode of formation and action of these singular heat-giving substances.

Dr. Frankland has made various experiments on the "Igniting Point of Coal-gas," and has found that coal-gas cannot, even under the most favourable circumstances, be inflamed at a temperature below that necessary to render iron very perceptibly red-hot by daylight in a well-lighted room, but this is considerably below a red-heat visible in the open air on a dull day; and this high temperature necessary is chiefly due to the presence of olefiant gas and other hydro-carbons in the coal-gas. Explosive mixtures of coal-gas and air may be inflamed by sparks from metal and stone, as from the tools of a workman excavating the ground, &c. Explosive mixtures of the gas of coal-mines and air require a far higher temperature for ignition than similar mixtures of coal-gas and air; and, therefore, the use of the safety-lamp is far more effectual in the former case than it would be in the latter.

The last ascent of Mr. Glaisher in a balloon, at Wolverhampton, is full of interest: he ascended to the unprecedented height of upwards of six miles, the reading of the barometer being at that height about eight inches; the temperature of the air was exceedingly low, at least thirty-seven degrees below the freezing-point of water; the readings of the instruments at the very highest point were rendered impossible by Mr. Glaisher having become quite unconscious, and Mr. Coxwell, the aëronaut, nearly so, indicating that an altitude of between five and six miles is nearly the limit of human existence.

Professor Chadbourne, of America, has shown that, if a spoonful of dry powdered ice or granular snow be thrown into a smooth glass vessel nearly filled with water slowly boiling, strong ebullition is produced, the particles of ice or snow acting like particles of iron or sand would under similar circumstances.

A discourse was recently delivered, at the Royal Institution, by Mr. Faraday, "On Gas Furnaces," and was chiefly devoted to an explanation of the construction and action of the "Regenerative Gas Furnace" of Mr. W. C. Siemens, of London. This arrangement of heat-generator is rapidly becoming employed for all great furnaces where a very high degree of heat is required, such as in iron puddling, iron-tube welding, glass-making, &c., chiefly in consequence of its economy in enabling the very commonest kind of coal (called "slack") to be employed instead of a better quality, and with the production of a very much greater degree of heat,—so great, indeed, that on several occasions, when its management has been neglected, the most refractory clay-vessels have been softened and destroyed.

ZOOLOGY.

The Posterior Lobes of the Brain in the Lower Animals.—The controversy raised by the statement of Professor Owen, that the posterior, or third, lobe of the cerebrum (brain proper), is peculiar and common to the *genus homo*, and that certain parts found in the hind lobe are equally restricted to man, still attracts the attention of physiologists and comparative anatomists. Dr. Turner, Demonstrator of Anatomy at Edinburgh, agrees with the oppo nents of Professor Owen, that it is now fully proven that the Quadrumana (monkeys) possess a posterior lobe, with its characteristic parts. He has also found very decided posterior lobes in the cerebrum of certain Cetacea (whales), as well as a high degree of complexity in the convolutions of the brain.

In-and-in Breeding of Domestic Animals.—It is a generally received opinion that in-and-in breeding, while it is extremely injurious in the case of the *genus homo*, is not accompanied by similar evils among domestic animals. A contributor to the *Comptes rendus* speaks thus forcibly upon this subject:—"Breeding in-and-in is, under no circumstances (as has been advanced by a forced interpretation of what passes in domestic animals), a practice favourable in itself, and altogether without danger. Far from it, it is for all species a cause of degeneration and decay. It is useful sometimes to have recourse to it as a necessary evil, to which one must submit in order to reap a counterbalancing advantage; but the practice should be discontinued as soon as there is no longer an absolute necessity for it."

The Unicorn.—Dr. Baikie, the African traveller, announces that he is upon the track of this, as hitherto supposed, fabulous animal. Writing from Central Africa, he says that several years ago he heard allusions to such an animal, as he ascended the Niger, which were so circumstantial that his scepticism was shaken, and, at all events, he is disposed to hold that its non-existence is *not proven*. Two informants told him they had seen the bones of such an animal, particularly describing the long straight (or nearly straight) black horn. He states that the hunters are well acquainted with the one-horned rhinoceros, and carefully distinguish between it and the presumed unicorn. No doubt the vast forests and unexplored wastes of Central Africa contain many unknown animals, and Dr. Baikie gives a list of native names by which this strange creature is called in various African dialects.

The Aye-aye.—The most remarkable addition made of late to the stock of living animals at the Zoological Society's gardens is an Aye-aye (*Cheiromys Madagascariensis*). This extremely rare and curious nocturnal animal has only comparatively recently been known even to the natives of the islands which it inhabits. Mr. Edward Mellish, of the Mauritius, going on a mission of congratulation to King Radama II., on his ascent of the throne of Madagascar, took such effectual steps, that, although he could not at that time procure a specimen, one shortly afterwards was forwarded to him, which has reached London alive and in good health.

Sounds produced by Mollusca.—The lakes of Ceylon contain shell-fish which, Sir E. Tennent informs us, produce remarkable sounds, referred by the Cin-

ghalese to species of the genera Littorina and Cerithium. Similar sounds have been observed in South America ; and a recent observer in the North, about Vancouver's Island, has discovered the existence of a similar musical mollusk in an arm of the sea running out of Victoria harbour. The sound was compared to that of a Chinese kite when flying, and which is produced by fixing pieces of metal to the kite's tail. The Indians were well acquainted with the sound, and referred it, like the Cinghalese, to a shell-fish, but the observer had not hitherto been able to obtain specimens.

The Young Fry of Anodonta Cygnea.—A remarkable fact in the history of this fresh-water mussel has been brought to light, viz., that the young fry are parasitic upon fishes. At the time of the exclusion from the ovum, says the Rev. W. Houghton, they keep constantly snapping together their valves, reminding one of the somewhat similar action of the *birds' heads* upon some of the marine polyzoa. After it has once snapped upon the fin of an unfortunate fish it appears to be quite stationary. In this condition they appear to be identical with long-known little creatures called *Glochidia*, from the two hooks which they possess, and deemed truly parasites. These hooks being barbed, it appears that the little mussel, having once fixed upon a fish, is unable to re-open its valves. It is not known how long they remain in this parasitic condition, nor what changes they undergo before becoming adult anodontæ.

Acclimatization of the Silk-worm.—M. Blani, of the department of Marne et Loire, describes in the *Revue et Magasin de Zoologie*, the success with which a species of silk-worm (*Bombyx Cynthia*) has been reared at Anjou. He describes the appearance presented by the worms covering the branches of trees largely cultivated for that purpose. As many as 500,000 worms were placed upon the trees, and were doing well ; most of them had changed their skin three or four times, and some were already spinning their coccoons among the leaves. The tree on which these insects feed is the Ailanthus, (natural order *Xanthoxylaceæ*), a native of China, but very hardy and easily acclimatized.

The Agricultural Society of Indre et Loire has voted a sum of money for the cultivation of the mulberry, in order to increase the food of the true silk-worm (*Bombyx mori*).

Diseases of the Silkworm.—These occupy to a considerable extent the attention of the silk cultivator. It has recently been discovered that uric and hippuric acid in the blood of the moth is a frequent cause of sickliness. The morbid product ceases to show itself when the insects are supplied with good food in the open air.

New Mygale.—A new British species of this genus of spider has been found at Brighton—*Dysdera erythrina.* Previously only one was known in England. These insects are remarkable for the caves some of them construct of earth, having a distinct door or lid ; and for the probably fabulous tales of some of the larger species' propensity for *catching birds.*

Borings of Limnoria terebrans.—This minute crustacean, which, though only two lines in length, exists in such numbers, and is so destructive in its boring propensities, as to cause great havoc to ships and submarine wooden structures, has hitherto been supposed to have received a check from Bethell's patent creosote process. Mr. D. Stevenson has, however, stated, as the

result of his experiments, that he has now ascertained beyond all doubt that creosote is not a universal or permanent preservative of timber used in marine works.

Anatomy of Sponges.—Dr. Bowerbank, who is well known to have long paid much attention to this lowly order of organisms, rejects the term Amorphozoa, or shapeless animals, proposed by De Blainville, adopting instead that of Dr. Grant, viz., Porifera, as the porous mode of imbibition of nutriment is universal in the class. He divides sponges into three classes, according to the nature of the skeleton, placing those first which contain calcareous spicula, the siliceous sponges second, and those with a horny structure, formerly placed first, are degraded to the lowest rank.

Physiological Teaching in the Higher Schools.—Dr. Acland, Regius Professor of Medicine at Oxford, has addressed a letter to the teacher of physiology in the grammar school of Magdalen College, in which he strongly advocates physiological study; and, as the best method, he recommends the collection of the Fauna and Flora of the neighbourhood, dissections of common animals, and microscopic research. He proposes to have precise osteological monographs of common typical animals, written by experienced physiologists, and illustrated with *objects*, instead of plates, which, though they would be more costly, would at the same time be more durable. In connection with this subject, we may call attention to the useful and interesting series of illustrative dissections, by Mr. Charles Robertson, of the Oxford University Museum, which may be seen in the Educational Department of the Great Exhibition. These are precisely the kind of illustrations required, and might be prepared in any number by Mr. Robertson, or by Mr. Flower, of the Royal College of Surgeons.

POSTSCRIPT.

Since our Astronomical Summary went to press, the following additional intelligence has been forwarded to us:—

A new planet has been discovered by M. Luther, but, being near the position of the lost "Daphne," it has not yet been decided whether it is the latter or a hitherto unknown object.

The transits of Titan's shadow have become a matter of some curiosity during the disappearance of Saturn's ring. It has been placed beyond doubt that they are well seen even in common telescopes. On April 15, Mr. Gorton observed this phenomenon with a telescope of 3¼ inch aperture, and a power of 170 and afterwards of 100, and says that the shadow of this satellite was almost as easily seen as a similar appearance on Jupiter. Mr. Dawes computes the synodic period of this satellite at 15°,967. The latter observer considers, from recent observations on the ring of Saturn, that this portion is of almost inconceivable thinness, and much less than the forty miles ascribed to it by Professor Bond. Mr. Dawes imagines, also,

from the appearances observed by him, "the existence of a pretty damp atmosphere on the rings," which, by the refraction of the light of the sun, would account for the visibility of the ring even when the illuminated surface is turned towards the earth.

Mr. Huggins draws attention to the *inactive* state of the clouds and belts of Jupiter in 1858 and 1859 as compared to the changes which were constantly going on during its last appearance. As both Jupiter and Saturn will be visible during the coming winter months, the beforementioned phenomenon will doubtlessengage the attention of many of our readers.